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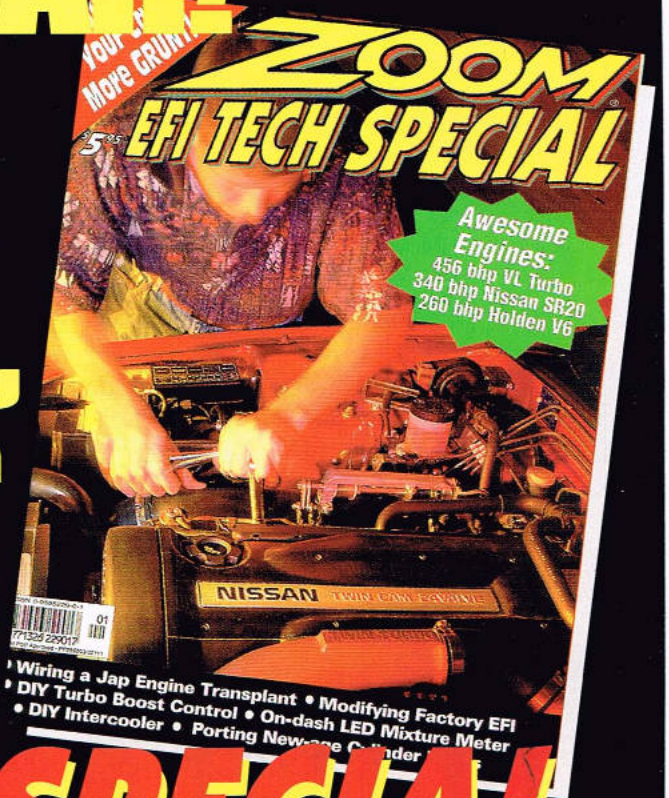
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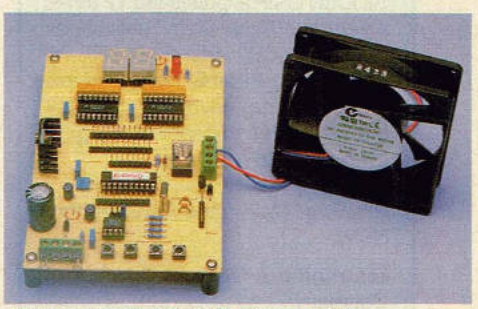

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PUBLISHER'S LETTER

Solar cells becoming ever more efficient

Solar cells are one of those products which are a bit of a sleeper. Sure they're handy if you have a boat or a recreational vehicle and they do a good job of keeping your batteries charged if you are away from mains power. And they are increasingly being used for remote communications. Apart from that though, they are bit of a yawn aren't they? They're still too expensive to contemplate for power generation unless you are "out in the sticks" and so most people don't even think about them. Or at least, I don't.

But recently, there was a news item which made me sit up and take notice. That famous solar cell development team at the University of NSW, comprising Professors Martin Green and Stuart Wenham and their devoted research staff, have just been awarded the Australia Prize. This is the nation's most prestigious and valuable science prize, worth a total of $350,000.

They received the prize for their continuing work on solar cells. Currently, they have pushed solar cell technology to an efficiency of 24.5%. 20 years ago, 15% was the accepted limit. Now, using present technology, they reckon 28.8% is the limit but they are continuing their work to push it further. They are also predicting that the cost could eventually drop to $1 per watt.

Now these figures mean that we are getting to the point where solar cells must be regarded as a mainstream energy source. An efficiency of 25% certainly rivals that for the whole coal/energy generation/distribution process, especially when the cost of coal extraction is considered. But solar power has the virtues that it is continuously renewable and does not continually contribute to air pollution or carbon dioxide emissions.

More importantly, an efficiency of 25% means that solar panels will get a lot smaller than they are today while their output rises. This means that you could have a 5kW or 10kW array which would fit on or be part of the roof of an average house. And at a dollar per watt, the cost would be only a small part of the cost of a new house.

Sure, there are still batteries to consider but you can see that, probably within the next 10 years or so, a completely solar-powered house would be a practical possibility in most parts of Australia. You would probably rely on solar collectors for hot water but the rest of the electric load, including air-conditioning, could be handled by solar cells.

Those sorts of figures could also be applied to the majority of offices in Australia, particularly when you consider that most of the workload is carried out during daylight hours.

In colder, less sunny parts of Australia, where domestic heating is pretty crucial, natural gas would be the natural choice for its efficient and low pollution outcome.

Does this mean that many Australian houses and offices could eventually do without electricity from coal-powered generators? The answer is clearly yes. In the long-term, that must be a good result for everyone.

Leo Simpson

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Autopilots for radio controlled model aircraft

Everyone is familiar with the concept of autopilots for aircraft. They take over control of the aircraft and let the pilot have a rest from the humdrum of normal flight. But the concept of an autopilot for a radio controlled model aircraft is quite different.

By BOB YOUNG

The difference between an autopilot for a jetliner and one for a model aircraft is that while a full-scale aircraft always has a skilled human pilot on hand to intervene, an autopilot for a model aircraft lets an unskilled operator do the flying. A real aircraft's autopilot controls all flight functions, while a model aircraft's autopilot controls only aileron and elevator, as we shall see.

The story of how autopilots became a viable proposition harks back to early Russian attempts at biological control of crop pests. If that seems like an odd precursor, read on.

The development of autopilots for model aircraft goes back a long way and probably began with the first R/C models. However, the first serious commercial attempt to create a viable low cost autopilot would probably be the device designed by the renowned American R/C pioneer Maynard Hill. Maynard set several altitude records for R/C models in the early 1960s, some reaching nearly 10,000 metres.

Now the problem with high altitude flying is that of keeping the model in the correct attitude to achieve best rate of climb. At any sort of altitude it becomes almost impossible to tell if the model is climbing or diving, let alone tell if it is at the best climb angle. It is also very easy to tear the wings off a model if the pilot is unaware of speed build up in a dive. It is here that an autopilot becomes invaluable.

Maynard's device used radioactive isotopes, such as those found in some smoke detectors, in the sensors and these were mounted on the wing tips, nose and tail of the model. The principle of operation of this device was extremely clever and relied upon the gradient of the electrostatic field surrounding the Earth. The voltage of this field diminishes with altitude and so if the model raised or lowered its wing tips or raised or lowered its nose or tail, a voltage differential was detected by the sensors. This was amplified and used to apply the appropriate corrections to the model aircraft's flight controls.

While this device worked very effectively, the radioactive components caused concern and it never found its way into popular usage.

This photo shows the original crop spraying model aircraft which was fitted with an optical autopilot so that unskilled users could fly it.

Russian development

The autopilot described here had its beginnings in 1975, in Russia, when Igor Tsibizov, fresh from military serv-

This view of the crop sprayer shows the hole at the end of the wing spar through which the paper balls were ejected.

ice, arrived at the SKB-AM (Student's design office for aeromodelling) and began work there. Igor was soon approached by A. S. Abashkin, the chief of a mechanisation department at the Kishinev Institute of Biological Methods of Plant Protection. His brief was in regard to the development of model aircraft to scatter wasp larvae over crop fields.

It appears that the USSR was amongst the first countries in the world to recognise that the large-scale use of chemicals in farming was not a wise practice. They therefore embarked on an extensive program of biological methods of pest control and this became very large in relation to the rest of the world. In 1990 alone, the USSR claimed to have treated 27.6 million hectares with a parasitic wasp (Trichogramma) that lays its eggs inside the larvae of crop pests.

Now the cost of delivering the wasp larvae was, and still is, a serious concern. Normal methods of delivery include tractor, aircraft and helicopters, with rates of treatment ranging from 100 to 250 hectares per hour. Divide 250 into 27.6 million and you get a lot of hours.

It turns out that this Trichogramma wasp is very tiny and this means that the aircraft are flying with a very peculiar cargo, about 2kg of tiny paper balls! There have been over 70 species of Trichogramma used around the world but of these only about 20 species have been mass-reared for field use. And this in itself is a very interesting story.

In the project that Igor worked on, the biological plants cultivated the larvae to the chrysalis phase, at which point they were placed in darkness, whereupon their development was suspended. The transformation of the chrysalis into an adult wasp can only take place in the presence of light.

The chrysalises were then packed into paper balls about 10mm in diameter, without any food. Still without light, the chrysalis remained in suspended development. Just prior to being dropped over the fields, the paper balls were pierced with a sharp instrument, thus letting in sufficient light to allow the wasp to resume development. Within 24 hours of being dropped, the adult wasp would emerge from the paper ball and immediately look for a suitable host for its eggs. The eggs develop into larvae which eventually kill the host, thus achieving the pest control function.

Approximately 400 balls were dropped per hectare and in tests conducted in Moldavia and Krasnodarskiy Krai, the system worked well. But clearly, the balls weigh practically nothing and so a full size aeroplane is flying almost empty, merely carrying air in the balls. With aircraft and helicopters being very expensive to run, it becomes obvious that there are great savings to be had using model aircraft to deliver the wasps.

However the real saving comes about if the farmers can manage the model themselves and it is here that the autopilot is not a luxury but an absolute necessity.

Solving the problems

The development of a suitable model aircraft was a major project. It was immediately apparent that the highest level of automation was required and all of this had to fit into a model aircraft of modest dimensions. Remember here that all of this took place from 1975 onwards. Miniaturisation was only just beginning and the autopilots available in those days were confined to Maynard Hill's electrostatic system and some small military gyroscopes, which were far too big and bulky.

Maynard's device proved to be unsuitable because the flying took place at an altitude of no more than 3 metres and changing atmospheric and Earth field conditions caused serious instability. And the one thing you do not need when cruising at 3 metres and 100km/h is instability!

Igor went through an intense period of trying all sorts of devices, rang-

Flying only a few metres above the crop, the plane would release hundreds of tiny paper balls over each hectare. Each paper ball was pierced at release so that the developing wasp inside could escape and release its eggs.

ing from the simple to the exotic, before finally settling on an optical system of sensing.

In the optical system an array of four photodiodes was arranged to "look" in four directions, to the left, right, front and rear. In effect, the diodes "look" at the horizon and they sense the line between the bright sky and the darker ground.

Operating principle

The operating principle is quite simple. As long as the outputs from all four photodiodes are equal, the output from the autopilot is zero. If the model begins to drop its nose, for example, the rear diode will "see" the bright sky and the front diode will "see" the darker ground. This will develop an error voltage across the sensor array and this voltage is fed to the processor in the autopilot. The processor then sends a correction to the elevator servo which results in an UP elevator correction being applied.

As the nose comes up, the error voltage diminishes until equilibrium is re-established. The more clearly defined the horizon is, the better the system works. Two obvious disadvantages to this system are that no night flying is possible and snow and haze can cause serious resolution problems. However, for most conditions the system works well.

It is important to note that this autopilot will not control altitude or direction (yaw). It is merely a device to maintain level (horizontal) flight. However, this is the hard bit and it leaves the pilot plenty of time to concentrate on direction and height.

The original agricultural aircraft was a rather unusual looking model fitted with some very unusual mechanics. The fuselage was a basic fibreglass shell with one former upon which almost all of the mechanical components, engine, scatter mechanism, main undercarriage and struts, were mounted. The engine was a standard 10cc 2-stroke, attached via a shock-absorbing mount. The fuel tank was under the engine and thus used a fuel pump.

The wing was foam covered with polyester film. The wing spars were made of titanium pipe 18mm in diameter and also acted as spray ducts for the paper balls. The scatter mechanism was driven from a small turbine mounted in the air collector. It took the balls, punched a hole in them and then delivered the ball along with a portion of air to the hollow wing spars. Thus the balls shot from the wing tips. An additional outlet shot balls directly downwards. Up to 2000 balls could be carried per flight.

In operation, the aircraft treated approximately 100 hectares per hour and was flown successfully by unskilled operators; all in all a significant achievement.

Present day autopilots

As a footnote to this biological control story, the patents to the autopilot were sold overseas and form the basis of the HAL-2100 and PA-1 autopilots now available in most model shops. It is also sold as the Graupner AP-2000. Included in this article is a photo of the latest version, soon to be marketed by Silvertone Electronics.

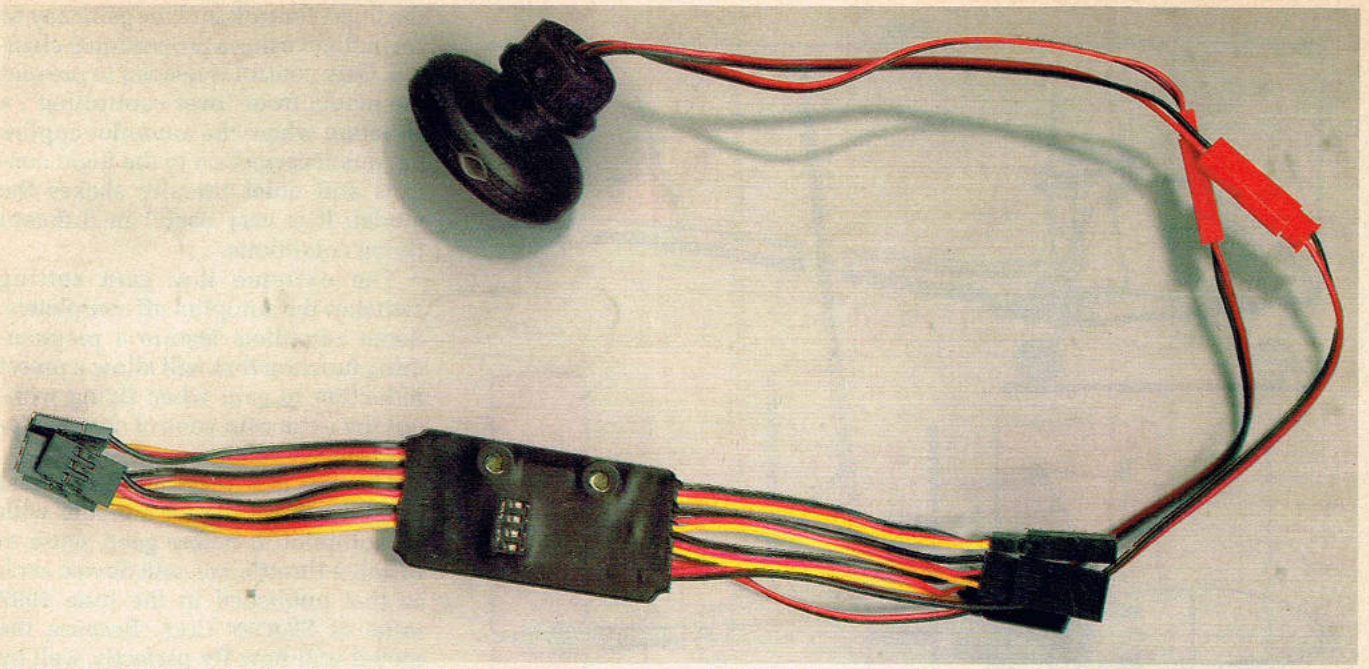
As can be seen from the photo, there is a mushroom-shaped module and this houses the four photodiodes. The module is mounted under the model in a very precise manner. There a number of important points in the installation. Briefly, they are the alignment of the sensor head in the correct sense; ie, the front diode of the fore/aft pair is actually pointing to the front of the model. To assist in this, the housing is marked with two small arrows, one for the "+" mode and one for the "X" mode.

In the "+" mode, the diodes point to the front, back and to the two sides. In the "X" option (45° to the line of flight), the photodiodes point to the left/front, right/front, left/rear and right/rear. This mode is available because it sometimes helps eliminate shading from wing-mounted undercarriages and mufflers on side mounted engines. A DIP switch is used to select this option.

The second point in the installation is that the alignment of the diode array must be perfectly horizontal in relation to the tailplane. Finally, a trainer installation should have 2-3° pitch offset which will result in a gentle climb.

It is not recommended that the module be mounted on the top of the model because bright sunlight can cause serious problems. Often the model will turn towards the Sun and possibly enter a shallow dive. The photodiodes in the array are set well back in a small tube in the sensor head moulding to provide additional shielding from bright sunlight.

Before each flight it is important to check that these holes have not been blocked by dirt, grass or other debris. A blocked or dirty hole will cause a serious imbalance in the sensor in-



This is the current model autopilot which is microprocessor controlled. The mushroom-shaped module contains the four photodiodes which look at the horizon. This model will be marketed by Silvertone Electronics.

put. Side mounted motors present a particular problem here because the oily exhaust gas is sprayed over the sensor head; this installation is not recommended.

Photodiode memory

One interesting point in regard to the photodiodes is the problem of memory. If the sensors have been left in the dark for a length of time or the model has been stored, initially they may not work correctly. A simple analogy would be if a person is kept in the dark for several hours and then brought out into bright daylight. It then takes some time for that person's eyes to adapt to the higher light levels. Thus, it is recommended that the module is left in daylight in a bright area for at least 12 hours after removal from prolonged darkness. This allows the module to adjust to the light levels and balance itself. It is important to ensure that all sides of the module are exposed to the same light levels.

The output of the photodiode array is fed into a microprocessor which then applies the appropriate corrections to the two main flight controls, aileron and elevator. In essence, this is similar in action to the in-line mixer published in the July 1997 issue of SILICON CHIP, in that the output from the receiver goes into the autopilot and the servos plug into the auto pilot, making it an in-line device. However, in this case the mixing occurs between the light source inputs and the channel inputs, not between channels.

As the transmitter control sticks are moved off-centre, the effects of the autopilot corrections are reduced. However, when the sticks are returned to neutral, the full effect of the autopilot control corrections are applied to the controls and the model returns to horizontal flight.

Thus if a beginner is using the system on a model aircraft and he gets into difficulties, then all he need do is let go of the controls and the model will return to horizontal flight automatically.

An additional channel is required to adjust the gain (or sensitivity) from the transmitter for the most successful operation of the optical autopilot. The gain control sets the amount of correction the autopilot will apply to

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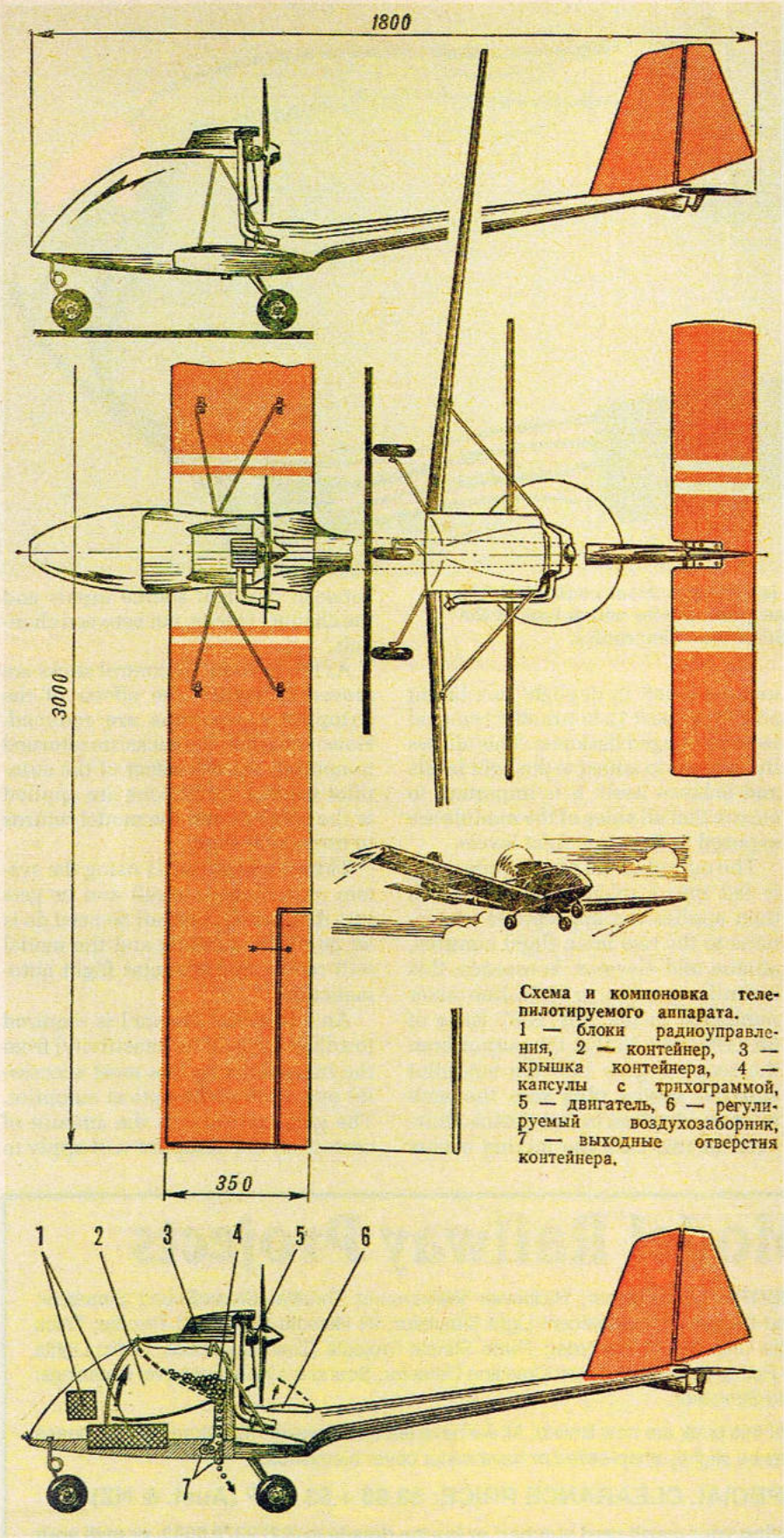

Схема и компоновка телепилотируемого аппарата.
1 — блоки радиоуправления, 2 — контейнер, 3 — крышка контейнера, 4 — капсулы с трихограммой, 5 — двигатель, 6 — регулируемый воздухозаборник, 7 — выходные отверстия контейнера.

These cross-sectional drawings show the construction of the crop-spraying model aircraft and the hollow tubing used as wing spars and spray outlets.

the flight controls and the gain may be set in flight using a proportional channel. Gain control is needed to prevent the model from "over controlling", a situation where the autopilot applies too much correction to the flight controls and quiet literally shakes the model. It is very useful in different flying conditions.

The extreme low gain setting switches the autopilot off completely. Some autopilots feature a programming function that will allow a preset reduction in gain when flying without the extra gain control channel (4-channel systems).

There is one very important final point when setting up a model with an autopilot. It makes good sense to install a throttle fail-safe device such as that published in the June 1997 issue of SILICON CHIP. Because the model will now fly perfectly well by itself, a radio failure becomes a serious business. The model can fly long distances under perfect control from the auto pilot and could land goodness knows where. The throttle fail-safe will shut off the motor upon loss of signal and the autopilot will bring the model down safely in close proximity to the field.

Learning to fly

Learning to fly with an autopilot fitted is an interesting experience and it certainly speeds up the process remarkably as well as increasing the life span of the models and improving safety all round. In a model helicopter, the autopilot would be used to control the "cyclic pitch", thus keeping the rotor disc horizontal. Combined with a tail rotor gyro, this device can take most of the pain out of learning to fly helicopters.

Acknowledgments

- My thanks to Dmitry Bernt, Moscow, for bringing this story to my attention and providing the translations.
- To Alan Westcott of the Elizabeth Macarthur Agricultural Institute, Menangle, NSW for his assistance in providing information and advice.

- Worldwide Use of Trichogramma for Biological Control on Different Crops: A survey. Li-Ying Li. Guangdong Entomological Institute, Guangzhou, China.
- University of California, Riverside. http://insects.ucr.edu/tricho/tricho.html

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Getting started with Linux; Pt.2

Setting Linux up to dual-boot with Windows is relatively straightforward, although there are quite a lot of options to consider. Alternatively, you can set Linux up as the sole operating system on something as simple as a 386 or 486 PC.

By BOB DYBALL

One way to squeeze more life out of an old "cast-off" PC is to run Windows 3.1 or, depending on your application and the machine, plain MS DOS. On the other hand, Linux might just be the answer, particularly if you want to use the machine as a file or printer server, as a web server or in some other LAN or Internet application.

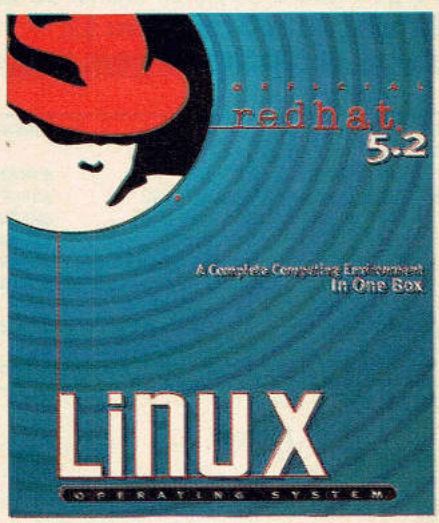
The big advantage of Linux is that you don't need fancy hardware with lots of RAM to run it. As many people have found, it will run quite nicely on an old 386 or 486 machine. Others consider Linux a fast, stable operating system that's cheap to buy and are installing it on Pentium, Pentium II and other late-model PCs.

What hardware do you really need to run Linux? Although there are a couple of enthusiastic groups trying to "port" Linux to XT or 286 systems (in other words, rewrite it), the usual mainstream Linux distributions need at least a 386. From there, you need to have a look at the uses you might put the system to, to see what CPU, RAM and other hardware you'll need.

Generally speaking, Linux will run on a system with as little as 4MB of RAM but really needs at least 8MB and preferably 16MB to move along reasonably well. If you plan on using X11 or Xfree86, Linux's version of X Windows, then 16MB should be seen as a minimum.

The amount of hard disc space required depends on the installation options you choose. If you want a simple file server and printer server, then you really don't need to install X Windows unless you want to run it occasionally to enable easier configuration. And that's the crunch – configuring Linux, for someone who is used MS DOS and MS Windows, can be rather scary.

A "small" installation will occupy 50MB to 200MB of disc space, depending on the options selected. More complete installations will require at least 500MB but if you are interested in recompiling the Linux kernel, then 1-1.5Gb would be desirable. This should provide enough room for the source code to be installed as well.



Linux Red Hat (from Red Hat Software) is a popular commercial distribution of Linux. The box includes three CD-ROMs, a boot floppy and a manual.

Note, however, that the sizes vary a little from one distribution to another, as some come with extras that the others don't have. Installing a minimal Open Linux system without X11, for example, requires 55MB. An average X11 setup will require about 137MB, while a larger installation with, say, DRDOS, NetWare client and Apache Web Server will need around 418MB. The complete works, with all options, will set you back 988MB.

Networking Linux

Networking Linux to machines running other operating systems is no problem. For example, Linux with the Australian "Samba" program installed can easily be networked with PCs running Windows for Workgroups 3.11, Windows 95, Windows 98 or Windows NT. The Linux PC "looks" as if it is just another part of a Workgroup, or even part of a Domain, sharing files or printers with others in the network.

Linux can also be used as a fax server, a modem server, a workstation running as a client in a Novell Netware network, or as a Unix workstation – all this for a fraction of the cost of many of the alternatives.

Hardware support

Support for popular network, video and SCSI cards is not usually much of a problem with Linux. However, you might find that some of the latest cards, along with some less popular older cards, aren't supported. If your network card isn't directly supported in its native mode but has an NE2000 emulation mode, it should work perfectly if you choose the NE2000-compatible driver. The vast majority of network cards fall into this category.

Some SCSI controller cards might

cause problems, although most popular cards are supported in the standard kernel distributed with Linux. If you have a SCSI card that's not well known, check to see if it's supported before attempting to install Linux.

Users of IDE hard disc drives will have an easier time but only for drives up to 8GB. Above this limit, Linux (like Windows NT) can become confused and detect only an 8GB hard disc when, in fact, you really have 10GB or more.

On the display side, you will need a video card that's supported if you want better than 640 x 480 screen resolution and 16 colours. Although your fancy new 16MB 2D/3D video card will have immediate support for Windows 98 or NT, you might have to wait for some time before support appears for it under Linux. As before, some older, less popular video cards won't be supported, so shop carefully if bargain hunting for hardware.

If you want to use your Linux box to connect to the net, or work as a "router" or firewall, then you'll probably find an external modem easier to debug (if necessary). That's because you can watch the lights, something missing on most internal modems.

Printer support is fairly reasonable. If your printer isn't listed in your Linux distribution, you can usually find something that's close enough by using one of the emulations listed in the printer's manual.

The printer control file can be rather interesting. This is basically a text file that covers the capabilities of the printer. One that's close to your printer can be modified to suit or you might write one from scratch by referring to the documentation in the "man" pages (on-line help) supplied with Linux.

Partitioning drives

There are a number of choices when it comes to installing and booting Linux. Some of these might seem confusing at first, especially if you are used to booting DOS or Windows 95/98 from the C: drive. Linux can be installed on a second or third hard disc drive (in DOS terms, say the D: or E: drive) and booted using a special boot manager called LILO (Linux Loader). LILO is supplied with Linux and it also allows Linux to be started using a boot floppy.

If you already have a Working Windows 3.11 or Windows 95/98 system, you could leave the C: drive where it is, add a second hard disc and install Linux on this new hard disc. Once formatted under Linux, this Linux hard disc drive will normally be invisible to your Windows 95/98 system.

Alternatively, if your C: drive has lots of room and you'd like to keep Windows there, you might consider installing Linux into the MS DOS filing system. Although not as efficient as an installation to Linux's own native format, it can still work in this way.

Another option, if you have lots of

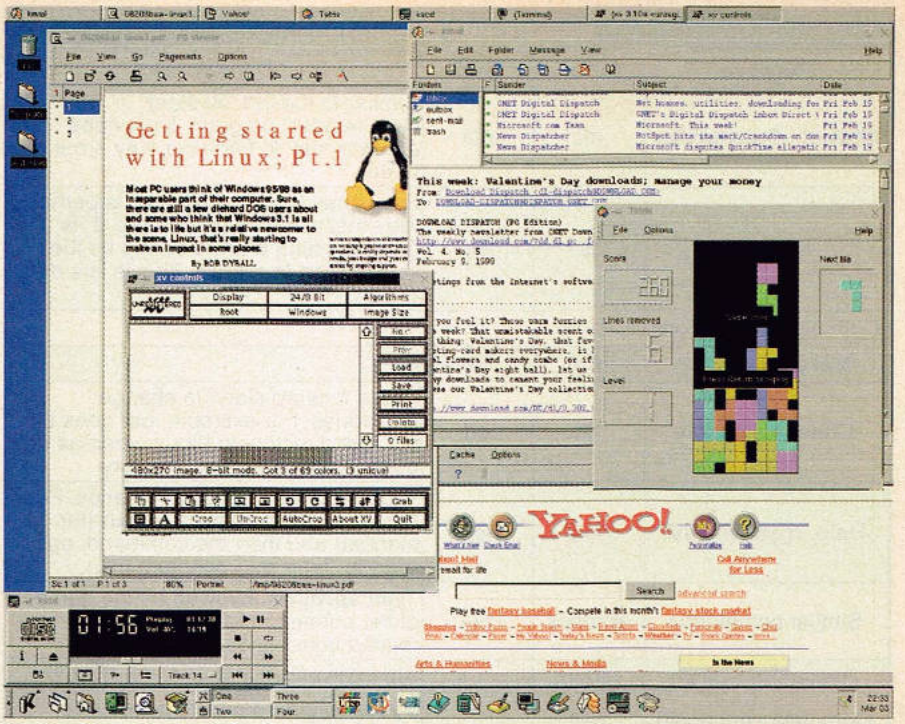


Fig.1: this screen grab shows Caldera OpenLinux 1.3 operating in XWindows and running the KDE desktop manager. This has a similar look and feel to Windows 98.

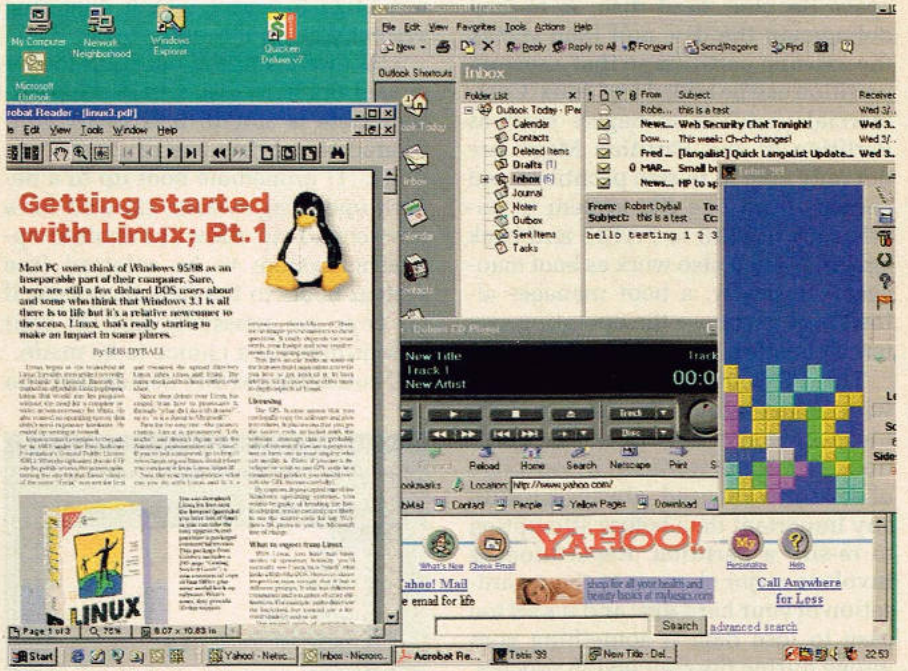


Fig.2: by way of comparison with Fig.1, this screen grab is from Windows 98. There are many similarities between the two.

Basic Linux Commands			
Purpose	**Linux**	**DOS**	**Comments**
Midnight Commander	mc	n/a	Similar to the old "System Commander" program. It provides an easy way to find your way around Linux.
Directory	ls	dir	Has a number of switches. l is perhaps the most useful. For example, if **ls** gives a listing that's too long for the screen, use **ls l more**. This is like dir/p in DOS.
Commandline options	--help	/?	
Make a directory	mkdir	md	
Change directory	cd	cd	Use a forward slash to change directories. For example, **cd/** goes to the root directory in Linux whereas **cd** goes to the DOS root directory.
Help, command list	help	help	Type **help** for a list of commands. For more complete help, type **man** (for manual) and then the command, eg: **man ls**. Type **q** to quit from man.
Similar commands	apropos	n/a	Type **apropos** followed by the name of the command for a list of similar or related commands.
Restarting system	reboot		Alternatively, use **shutdown -r now**.
Complete shut down	halt		If your version doesn't support this, use **shutdown -h now**.

space on your hard disc, is to first defragment the disc and then shrink the existing partition so that a second partition can be added for Linux. Commercial partition managers such as Partition It! and Partition Magic are not only able to re-size partitions and convert from one file system to another (eg, FAT16 to FAT32 and back again), but can also work as boot managers. Basically, a boot manager allows you to choose the operating system at boot up.

The FIPS utility, freely available with Linux under the Gnu or GPL License, is also able to re-size partitions. A word of warning: irrespective of the software used, always back up any important data before attempting to re-size a partition. Repartitioning involves major changes to the organisation of your hard disc and it's all too easy to lose data if something goes wrong during the conversion process.

Check too that you are using the latest version of the software. FIPS 1.5 will not support FAT32 whereas FIPS 2.0 will, for example. Do not attempt to use Fdisk to repartition your disc – you will lose data if you do.

The safest approach, if you want to keep your original Windows operating system, is to adopt the first suggested method; ie, add a new hard disc, install Linux to this drive, and use LILO to select which operating system you want to use.

LILO writes to the partition loader area of the hard disc where the partition table is stored. It is easily configured to provide one of several options: (1) immediate boot up to a default operating system; (2) wait for a few seconds to allow the desired operating system to be selected (the system boots to the default system if no keys are pressed); and (3) wait indefinitely for a choice to be made.

If you subsequently decide that you don't want LILO on your hard disc and want to use a boot disc or some other method of booting, it is easily removed by typing (at the DOS prompt): FDISK /MBR

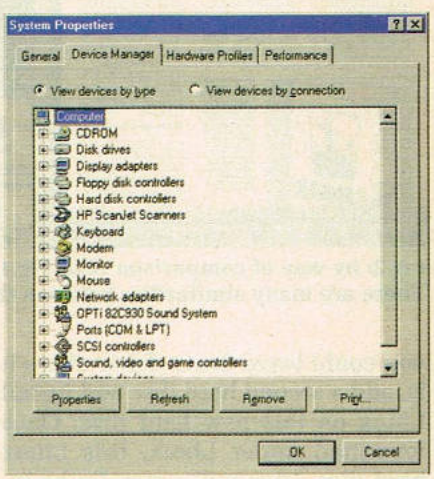


Fig.3: before installing Linux, use the System Properties dialog box in Windows 95/98 to obtain details on expansion card settings.

If you intend using Linux as a router and firewall for Internet access, it makes some sense to initially keep your options open and install Linux in a dual-boot with say Windows 95. By keeping Windows 95, you'll still be able to dial in and get your email or run a program such as C-Proxy (see SILICON CHIP, November 1998) while you get Linux up and running.

Pre-installation checkup

The main snag you'll likely run into here, especially if you're completely replacing the existing operating system, is figuring out the settings on your various I/O cards.

Most things, like COM1, COM2 and your printer port, are no-brainers – Linux can pick these up without any problems. However, if you have an internal modem, it will often be set to COM3 and an odd IRQ and it's useful to know this before installing Linux. Similarly, it might be useful to know the IRQ and I/O port settings for your network card.

In case you're wondering, the current version or "kernel" of Linux doesn't fully support plug and play (PnP). Some of the modules will detect the settings of PnP devices, while others might need to be set to manual (or non-PnP) mode. Newer releases of Linux will include increased support for PnP and USB (Universal Serial Bus) devices.

If you've already got Windows 95/98 installed, you can quickly find out what the settings are for each card via the System applet in Control Panel. To do this, double click the System icon, select the Device Manager tab then select an item and click the Properties button. From there, you can make a note of the IRQ and I/O settings for any network, video and sound cards or, in the case of a modem, its COM port setting.

If you have older non-PnP cards, you may have to temporarily remove them from the PC and refer to the manuals to discover the settings.

During the installation, you may find that there are some settings that cannot be changed or which aren't recognised. By knowing the settings beforehand, you'll save a lot of time

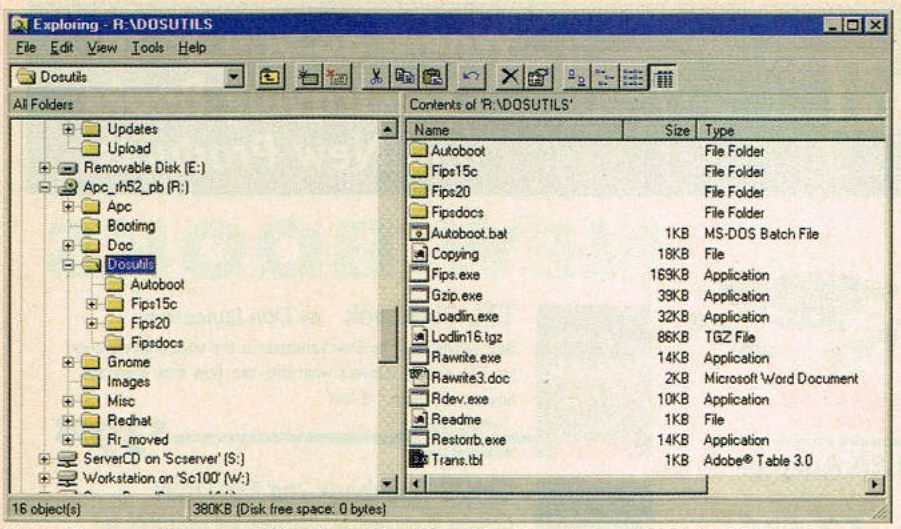


Fig.4: the rawrite.exe utility is in the /dosutils directory of this Red Hat Linux distribution. You use this utility to make a Linux boot disc.

when it comes to getting everything up and running after Linux has been installed.

Installation

OK, you're finally ready to install Linux. You've backed up everything that's worth backing up, you've got all the details on the add-on cards and you have a Linux CD.

Often, a Linux CD on it's own is fine, provided that the CD is bootable and the PC's system BIOS supports booting from a CD-ROM drive. If you have an older PC, you probably won't have the luxury of being able to boot from your CD (bootable CD disc or not). The way around this is to prepare one or more floppy boot discs from the Linux CD-ROM.

Commercial distributions usually come supplied with boot discs. However, if your Linux came from a magazine CD-ROM, a book CD-ROM or a low-cost GPL source, you will have to make the boot discs yourself. These are created from the DOS prompt (on blank DOS-formatted floppy discs) using a utility on the Linux CD called RAWRITE.EXE and an appropriate boot image file.

When you run RAWRITE.EXE, it initially asks for the source of the disc image file (eg, boot.img). If this file is in the bootimg folder, for example, you simply type **/bootimg/boot.img**. After that, RAWRITE prompts you to enter the target drive (usually A). In any case, be sure to consult the documentation supplied with your distribution for details.

Once you have the boot disc, you can use it to reboot your system and proceed with the installation. Alternatively, you can boot from the CD (if your system supports it and the CD is bootable). After that, it's just a matter if following the prompts and answering the odd question.

Most Linux distributions ask similar questions during installation, although some look prettier on screen than others. A progress bar is usually present and there's often some indication as to how far the installation has progressed and how long is left to go. Here, I like Caldera Open Linux, as you can press ALT-F2 to go to another "window" where you can to read a number of useful on-line help files, or even play a quick game of Tetris while the installation goes on in the background!

The first stage of the installation might ask where the Linux software is to be found. Assuming you've obtained a commercial distribution, this will be the CD- ROM but there are also some clever options to allow installation directly off the net (very slow unless you have ISDN). What ever you do, be sure to refer to the manual supplied with your distribution, particularly when it comes to selecting an installation class.

If you're planning on running a network, you will have to enter in your system's IP address, the domain name and the PC's name. If you don't intend connecting to the Internet, or even if you do and this system is to function as a firewall/router, use a domain name that's not valid in the outside world.

As an example, let's call the PC **fred**, assign it an IP address of 192.168.1.1, and call the domain **network.home**. The complete named address for the PC will thus be **fred.network.home**.

Your other PCs on the network must be given different names and IP addresses but note that the domain name (network.home) remains the same. Your local area network will function quite happily, despite not having a domain name with a conventional extension (eg, .com or .com.au, etc). However, you can still set up your PC to route traffic to these domains after dialling in to the net (more on this next month).

During the installation, if you select X11 or Xfree86 (the Linux "XWindows" look-alike), you may also be asked about your VGA card. Unless you are absolutely sure of what you have, it's best to select "Don't Probe" and configure Xfree86 after installation when you do have the necessary information. It can be quite annoying if you set the wrong card or monitor refresh rates and get stuck with a screen you can't read or a VGA card that's locked up.

If something goes wrong during installation, simply reinstall Linux over the top of the previous installation.

Next month we'll show you how to configure Samba, so that your Linux "box" can function as a file and printer server to a Windows network. We'll also describe how to set Linux up as a router, so that a number of people can share one Internet connection. Finally, to make it all safe, we'll set it up as a firewall, to keep some of the latest Trojans and nasties, like NetBus and Back Orifice, at bay. **SC**

Desperation Stuff

If you change your mind after an fdisk/mbr and wish to boot Linux, use the rescue image or the boot image to get out of trouble. This will get you back into Linux, after which you can reinstall LILO.

If you can't get into Windows 95/98, reconfigure LILO (type **man lilo** for the details) so that you can add the necessary information on the DOS/Windows partition.

Finally, if you want to toss in the towel on Linux, type **fdisk/mbr** at the DOS prompt to reinstate the Windows partition loader.

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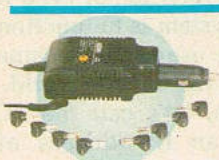

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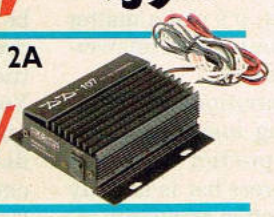

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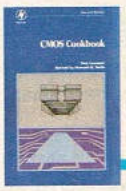

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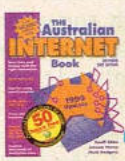

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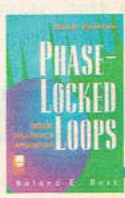

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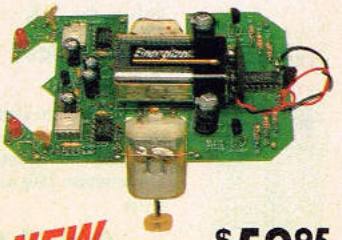

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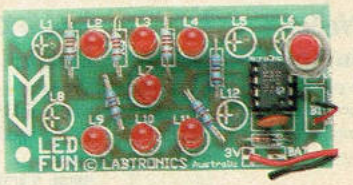
Predator module

Prey module

NEW **$39.80**



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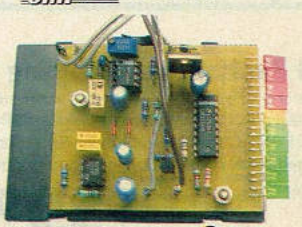
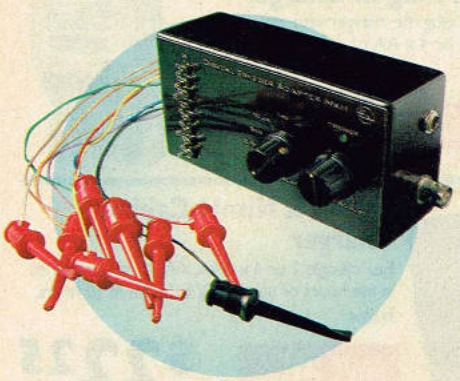
K 3167 — Silicon Chip Feb '99



Digital Trigger Adaptor, Mk II



- An updated version of the 1995 Digital Trigger Adaptor, utilising a complex programmable logic device (CPLD not included)
- The adaptor, when connected to a CRO, will trigger the scope when all relevant input conditions are met.
- Eight inputs (expandable up to 24 with slave units)
- Frequencies up to 20MHz
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- Source code included on floppy disc

K 1460 — EA Feb '99 **$59.95**

12V Car Ammeter

- Circuit measures voltage drop across negative strap
- 10 LEDs to indicate level of charge or discharge
- Displays levels between -25A and 25A on 12V
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- Power supply: 12V DC
- Includes all components and PCB

K 4612 — Silicon Chip Jan '99 **$16.95**

Electric Fence Controller

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- EMI Surpessed output.
- Much cheaper than commercial units
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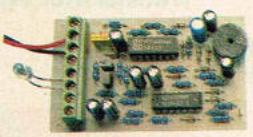
K 3009

Silicon Chip April '99 **$79.50**



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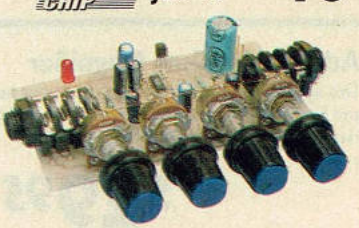
K 4301 — EA Jan '99 **$29.95**



Guitar Compressor

- 9-12V DC power
- Acts as an auto level control
- Audio effects including compression, sustain & limiting
- Accepts signals from guitars, microphones or similar
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K 5621

Silicon Chip Mar '99 **$29.50**

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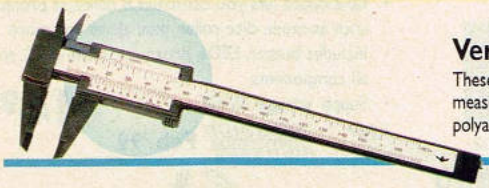

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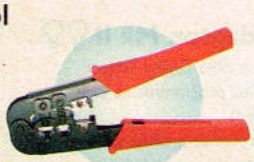
T 2920



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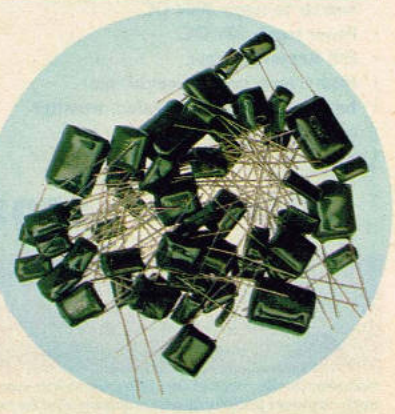

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Q 1407

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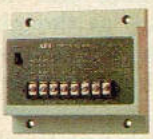

Features two independent N.C. (Normally Closed) sectors, instant and delayed; siren drivers capable of driving 2 x 8 ohm horn speakers, a 3A output relay, entry/exit delay 3-minute automatic cut-off siren timer and reset.

L5144

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This mulimeter is mains rated and suitable for 240V domestic mains measurements. Features a 3.5 digit (2000 count), max hold, data hold and a diode/continuity test. Comes with a protective rubber holster.

Q 1563

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This infra-red door beam is ideal for shop fronts and store rooms. Features alarm/chime/off mode and 7-metre range. Includes door beam, siren/chime unit, 10m cable, power adaptor, beam reflector and mounting brackets.

L 5900

EXCLUSIVE

$149

Brymen Multimeter

NEW

This superb quality Cat III 600V rated Digital Multimeter is safe to use with domestic mains measurements and housed in a splash proof and fire retardant case. Features frequency to 50kHz, Record Max, Min, Max-Min, Avg, Data hold, Resistance 999.9 to 40MΩ, Temperature -20°C to 500°C (unit) Supplied Probe (-20°C to 260°C), Capacitance 1.000uF to 10.00mF, Data updates 4 times/sec, Baragraph updates 20 times/sec plus more.

Q 1566

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20-Channel DSE Handheld UHF

NEW

This transceiver covers the frequency range of 433.750-434.225MHz with 20mW RF EIRP output. No license is required and the maximum typical line of sight range is 1km. Provides scanning facilities, CTCSS (sub-audible tone) selective calling with 38 available tones, a back-lit LCD screen, a fitted flexible antenna, plus a belt-clip and a carry strap.

D 1099

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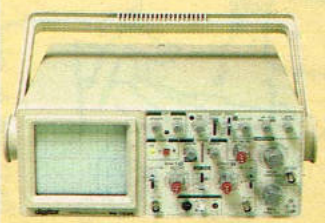
100MHz Oscilloscope



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SERVICEMAN'S LOG

The day my multimeter lied to me!

I have had a real mixture of sets this month, including one that bounced from last month and a couple more than 10 years old. They all produced their fair share of frustration but they were all beaten in the end.

I do make mistakes. There, I've admitted it; I'm not perfect. So shoot me.

Well, Mrs Evans may very well have felt like doing just that, with good reason. Last month I described how her Sony KVF29S Z 2 (G3F chassis SCC-G711-A) had no sound and intermittent east-west pincushion distortion. I had traced the fault as being down to IC303, the 12V switchable regulator.

It wasn't a hurried job. I did soak test it for well over a week before giving it back and it did go for almost a month after that before the original fault re-occurred.

While I'm in full flood, I should confess that there was another symptom which I hadn't really taken any notice of. The picture had looked slightly washed out, as though the tube had low emission which would have been surprising for a set less than four years old.

But when the fault was fixed, the picture had improved. So I thought nothing of it.

After delicately smoothing down some ruffled feathers and generally eating humble pie, I got back into Mrs Evans' TV problem. I thought it not unreasonable to apply the same medicine as before, namely replacing the PQ12RF21. It was quite possible that the new one had failed.

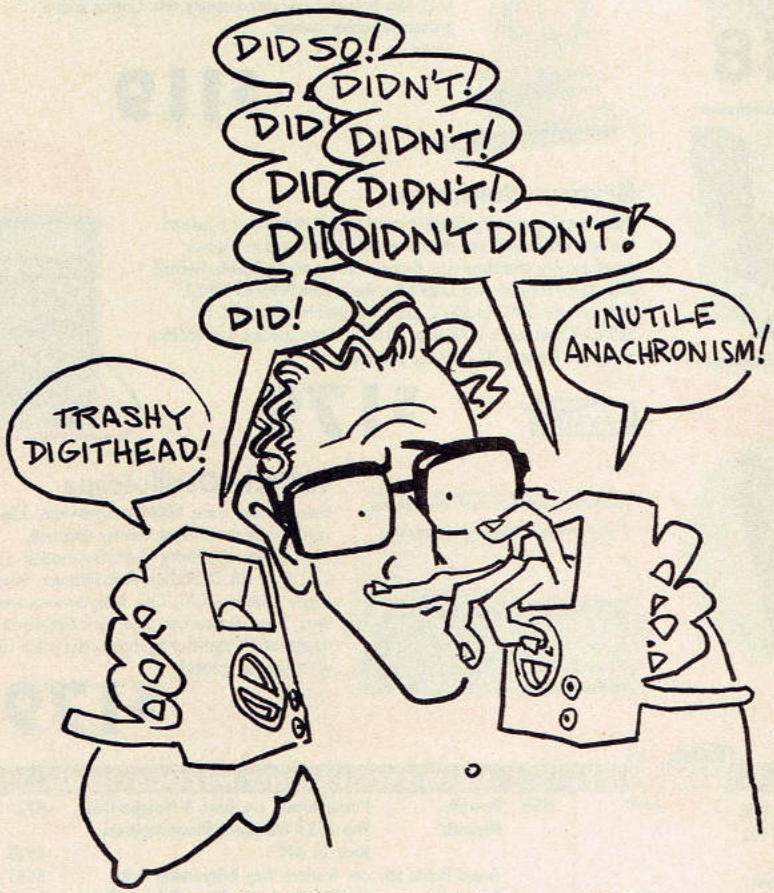
These PQ12 switchable IC regulators are made by Sharp and come in a series, with a choice of different numbers for the last four digits for which I am unable to find any data. I could obtain PQ12RF11 and PQ12R04 from my local supplier for only $4.00 or so, but to get hold of the PQ12RF21 would cost me $30 at trade price.

Why the last four digits should mean such a massive increase in price was beyond me as all the packages looked identical (TO-220 with four legs).

As the fourth leg is only the switchable pin, I eventually decided to use a 7812 3-pin regulator as a cheaper test substitute and only to prove the point. It was just as well as it made no difference to the symptoms. Obviously I was barking up the wrong tree.

Because I was making voltage measurements where only a few volts seemed to be making a difference, I thought using a digital meter was sensible and more accurate to monitor the voltages.

As the 12V rail was down to 11V on pin 2 and varying, I thought I would try downstream and see if the load was too great. I changed the Pin Con-



THE TWO METERS WERE FLAGRANTLY ARGUING WITH EACH OTHER

SETS COVERED THIS MONTH

- Sony KVF29S
- Sharp CX-4814
- Sharp VC-H865X
- Masuda T1092
- Bell & Howell VS-IC

trol IC2504 (UPC393C) but to no avail.

Next, I checked a bit further upstream to find that the voltage on pin 1 was also 11V and the 15V source was down to 13V.

I hung a few additional electros on the printed circuit side to see if this would change anything, on the off-chance that there were faulty ones on the component side, but it made no difference.

I then checked the main 135V rail to find that it was also low. Indeed, all the voltage rails were low, which would account for the poor picture. I also found that the voltages I read were different every time I switched the set on and off.

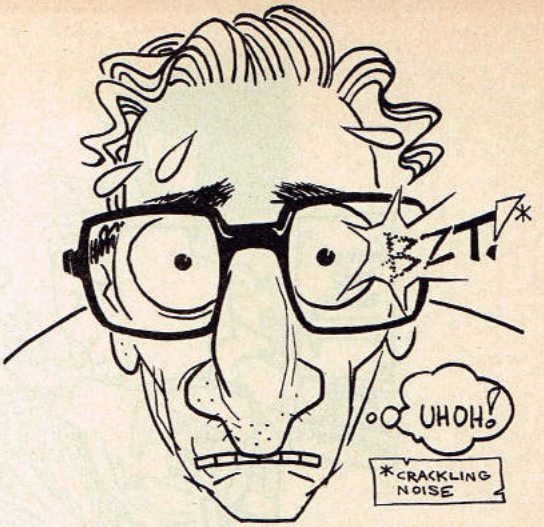
A bit disconcerted, I continued my quest. I thought that if the secondary voltages were low, the voltage reference must be faulty, so I replaced IC602 SE135. This is a common 3-pin regulator that controls the optocoupler IC600 PC111 to the main switchmode chopper, IC601 STR-S6708. The voltage on pin 2 of IC601 was 73V instead of 64.7V.

This made no difference until I changed the optocoupler as well, whereupon the fault suddenly cleared completely and the sound reappeared. Great!

But a glance at the multimeter showed that the voltage had now soared to 150V. I quickly shut down the set. This left just the STR-S6708 to replace, which I did.

Then just as I was switching the set back on, in the corner of my eye I noticed a spark and I heard a crackling noise.

I'm not sure that you would call this a lucky break, because in one sense it wasn't. I was indeed fortunate in seeing where it occurred but it surely caused some sort of damage – probably expensive! I had of course immediately switched the set off.



~I NOTICED IN THE CORNER OF MY EYE A SPARK AND HEARD A CRACKLING NOISE

The spark occurred at the ground (pin 10) of the chopper transformer, T601, and the printed circuit to this pin is bisected exactly at the pin so that it couples the negative sides of C613 and C616 through pin 10 to ground.

The spark was caused by an invisible hairline fracture under the lacquer and screen-printed component markings, right on the edge of pin 10 which is a solder rivet joint. Indeed it certainly was an expensive crackling noise because the damage caused was quite extensive, requiring the replacement of all my familiar friends, IC303, IC602, IC600 and IC601.

When I had done all this, it fired up correctly but the digital meter was still reading high secondary voltages. I couldn't bear this. What had I done wrong?

I left the digital meter monitoring the 135V rail and used an old analog meter to check the rails, especially the 15V & 12V ones. To my surprise, these read correctly.

This wasn't making much sense any more so I checked all the rails with the analog meter.

Guess what? They all read correctly, including the one that the digital meter was showing as 20V higher!

The two meters were flagrantly arguing with each other, so I got out yet

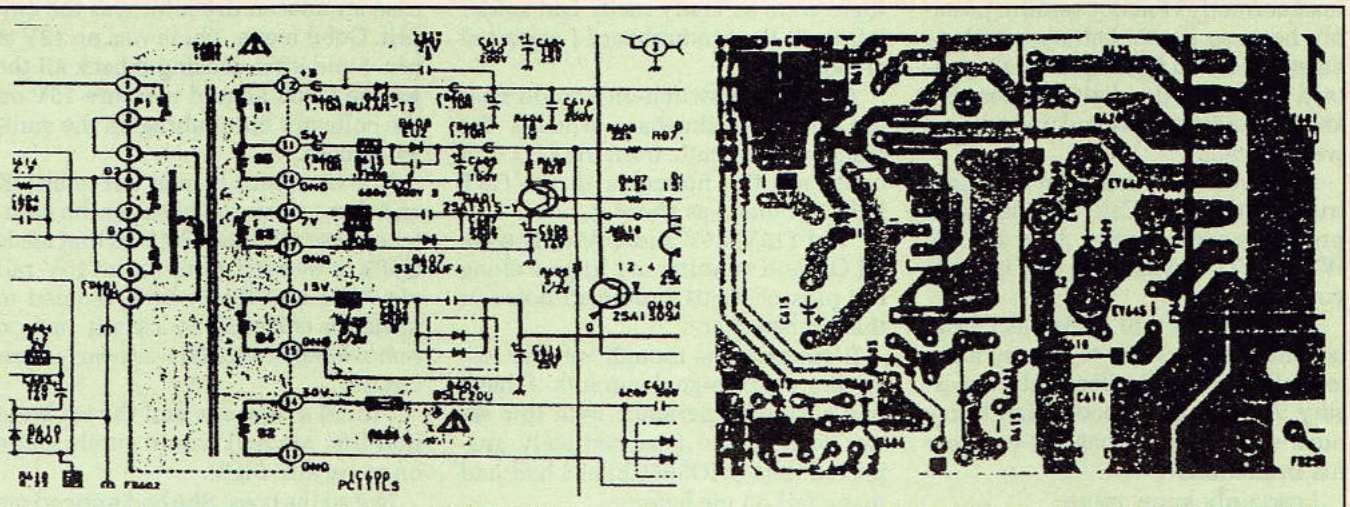
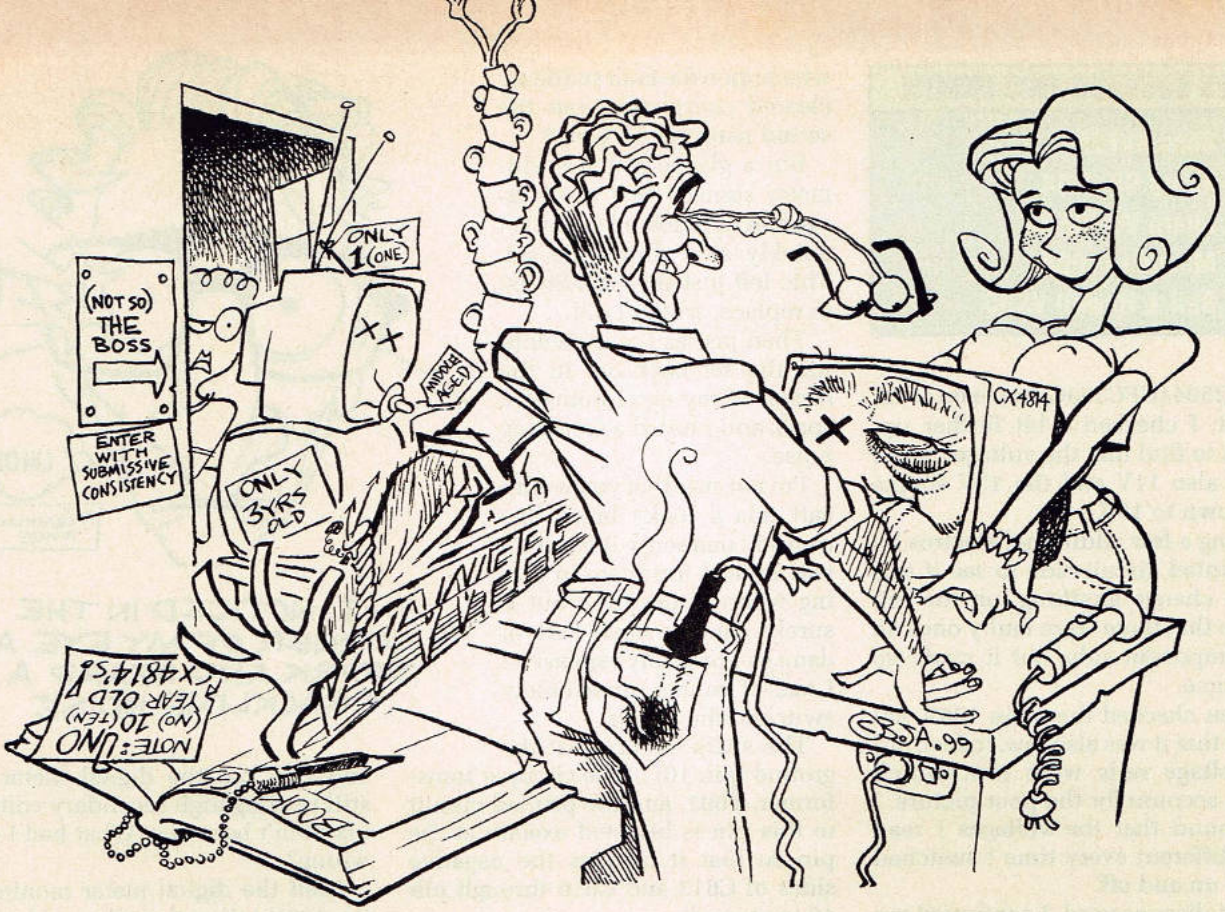


Fig.1: the relevant portion of the Sony KVF29S Z2. If you think that the reproduction is poor, it's not! This is typical of the circuit diagrams that service technicians have to work with. But it's a positive work of art when you compare it to the PC board component layout (right) which shows the same section.



NORMALLY I DON'T TOUCH TEN YEAR OLD TV'S, BUT MS BELL SMILED AT ME SO SWEETLY, I WAS BEGUILED...

another meter to determine which was right.

Fortunately, the analog one was correct which also meant that the set was now fixed properly. I think. And hope!

So why didn't the digital meter read correctly? I'm not certain; possibly because its 9V battery was low. Later on, after I had replaced the battery, I checked the digital meter on a known power supply and the voltages were correct.

However, I feel that I can no longer trust that meter. Call me old but I prefer the analog meter. After all, it is WYSIWYG – what you see is what you get!

The TV set is still on test as I write because I don't want to do any more grovelling than is absolutely necessary. As Clint Eastwood's Dirty Harry once said, "A man has got to know his limitations".

I certainly know mine.

The 10-year old Sharp

Normally, I don't touch 10-year-old sets but Ms Bell smiled at me so sweetly I was beguiled. She had struggled in with a Sharp CX-4814, which really isn't very heavy, but she had got this far so I guess I just had to fix it!

I certainly helped her carry it into the workshop. The set was dead but there were so many really bad solder joints on the motherboard I wasn't at all surprised.

Anyway, at switch-on I could hear the 15,625Hz timebase whistle, the crackle of the static from the EHT and could see the filaments in the CRT light but that was about it.

The 115V, 24V and 15V rails were all OK and running my fingers along the pins of IC201 produced noise in the loudspeaker.

It appeared as though we had lost all the small signal circuits. I have had a lot of experience with this series of sets and I immediately suspected I201 (IXO506CE) as I had had many fail on me before.

The major nuisance of this IC is that it has 30 legs and you can't buy IC sockets for it. Instead, you have to use socket strips. The other bugbear is the metal screening cage around it, which makes access poor. I really didn't want to change this IC as it is also very expensive.

So before I started I thought I would just check the voltage rail feeding it in case an unseen dry joint was the culprit. Good move. There was no 12V at pin 4 and after chasing it back all the way to Q603 I could measure 15V on the collector but nothing on the emitter or base.

The transistor turned out to be OK and there were no shorts on the emitter or base circuits. The bias that feeds Q603 is derived from the +115V rail via R624 and R645. Both seemed to measure correctly in circuit but on removal R624 (68kΩ) was nearly open circuit.

I fitted a new one and the set burst into life. Ms Bell would surely smile on me again. Sigh!

Not so the boss. She had noticed me booking in the set rather slowly and reminded me curtly of company policy on old sets. I slyly shrugged it off,

saying things were a little quiet so we should take on some of the dross and besides I did have a little expertise on these, from all our rental sets.

Just to prove the point about old sets, a young man brought in his Bell & Howell VS-IC TV/Video which would have been over ten years old too.

This set is an Australian hybrid of a Sharp X-3434D television and a National N-180EN video recorder put together with a bizarre add-on extension case.

Dead flyback transformer

The set was dead but I took the job on anyway in case I was accused of being inconsistent.

This was a mistake of course, because the headache of this model is detaching the extension VCR and case. It is held on with two plastic screws on the rear and four concealed screws on the side.

To make it worse, these screws are concealed with little plastic covers and are three inches deep inside the cover, too dark to see. It took me ages with the aid of a small torch to work out that they were 4mm Allen screws and you needed a really long shaft! Despite all this, I guess the easy part was taking it apart.

So was the diagnosis and replacement of the flyback transformer T601 (TRNF1412CEZZ). The really difficult part was getting the whole thing back together, especially as the screw retaining plastic washers had got lost.

Trying to get four Allen screws in simultaneously without one falling inside was extremely difficult. In fact, trying to get it all back together took longer than disassembling and repairing it.

The other major drama was that the TV set wouldn't work without being connected to the VCR via an interface which was too hard to juggle whilst disassembled. Things got even worse when I discovered after I had got it all back together that there was no sound.

There was nothing for it but to go back in. Swearing and sweating, many hours later I finally diagnosed and replaced IC301 (IXO250CE) and got it all back together again.

In the process of dying, the old flyback transformer had punctured the insulation and arced over and killed the IC. The reason I hadn't picked it up before was because of the additional TV mute button on the rear extension!

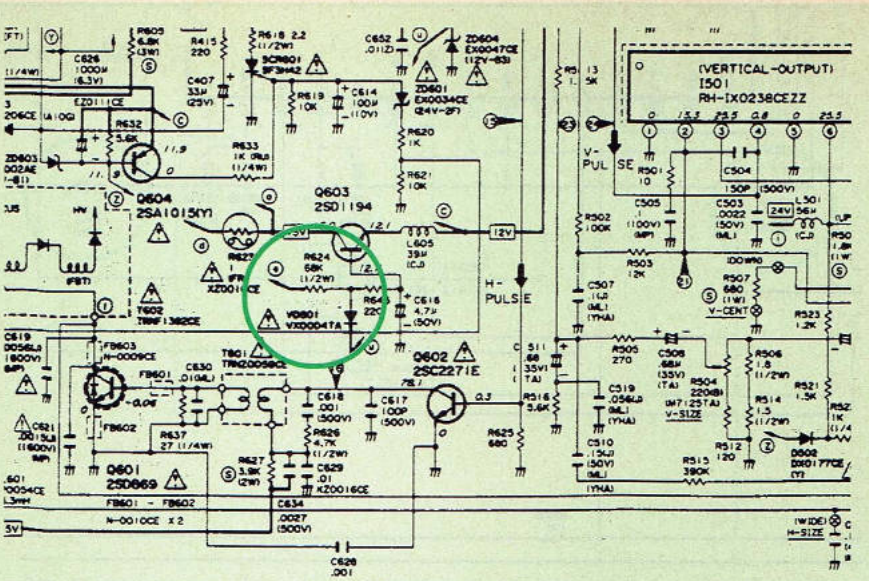


Fig.2: the trouble that one little half watt resistor got me into (and I'm not just talking about a difficult service job)! Still, ~~she~~ it was worth it in the end!

Aptly named . . .

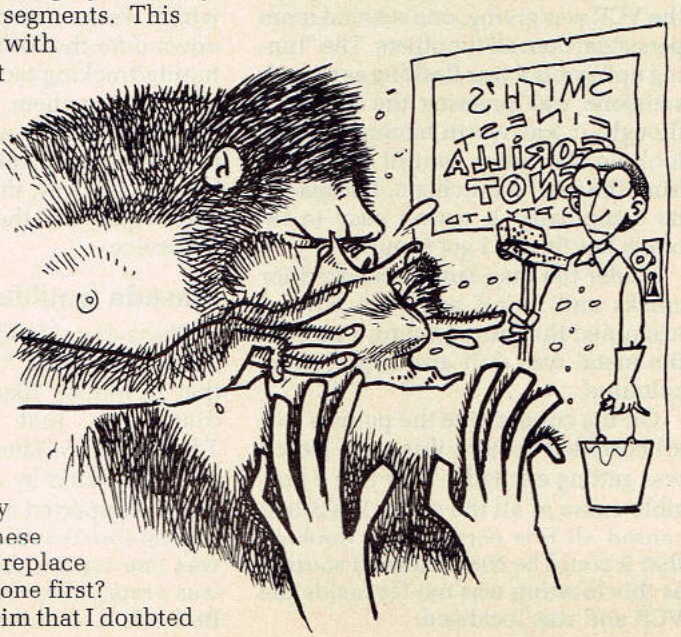
Mr Bradley brought in his beautiful Sharp VC-H865X hifi VCR. I say beautiful because not only did it look good but it was immaculate, as though it had just come out of the box. He had really looked after it.

This was a great shame because when he told me what the problem was I thought that might well be the end of it.

Its fault was that none of the controls worked and the display randomly showed different segments. This rang alarm bells with me, spelling out "expensive microprocessor". Not only that but sometimes they are very difficult to replace, especially if it is a 64-pin surface mount and sometimes it can be either one (Timer or Syscon) or even both ICs. The only way to confirm these large scale ICs is to replace them – but which one first?

Anyway, I told him that I doubted that it would be worth fixing and explained, as best I could, my dilemma with the above scenario. Initially crestfallen, he took it badly, so I said I would have a quick look and see if anything else might be causing it; otherwise I would advise him to get a new one.

The only things I could check were voltages, clocks, dry joints and cracks and possibly corrosion from the old brown glue – (aptly named gorilla snot.) It didn't take long to ascertain that all was perfect in the peripheral circuits to the ICs and it really looked as though replacing one or both was



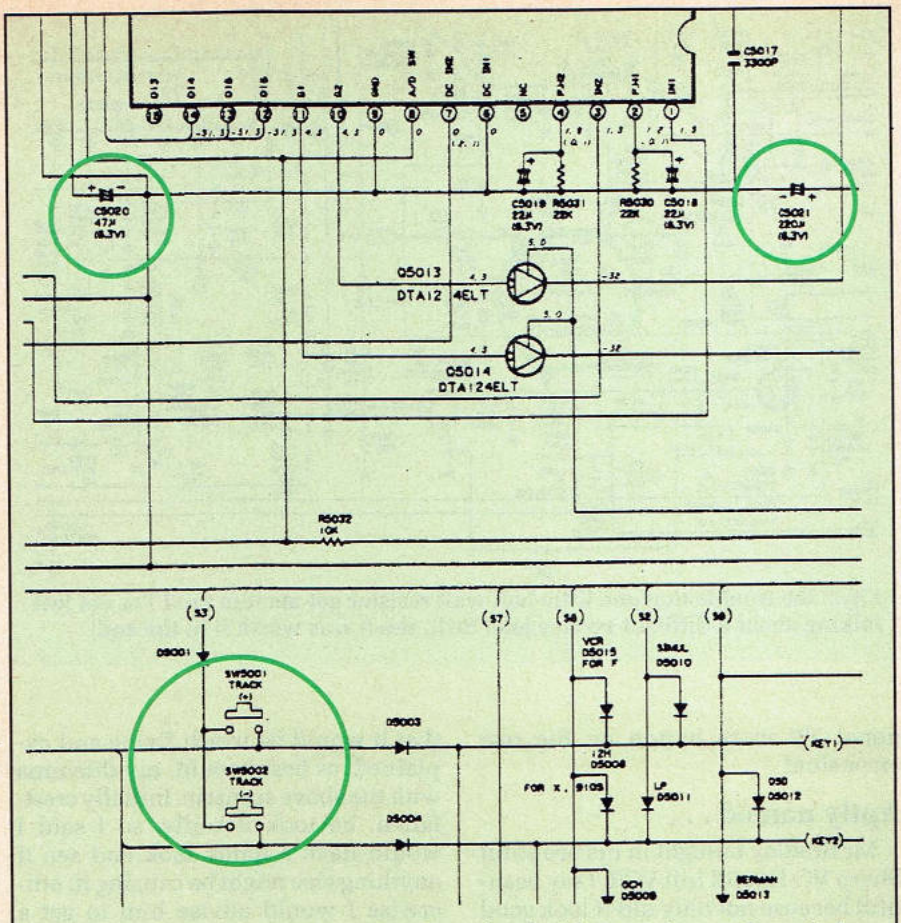


Fig.3: the electros were easy – pity they also decided to take out the switches in this Sharp VCR.

the only cure and that was uneconomical.

In the course of examining it, I noticed that of all the random displays the VCR was giving, one seemed more persistent than all the others. The "tuning up" symbol was flashing as though someone was pressing the button. I thought it was worth having a closer look on the timer control board behind the front escutcheon. Because of its complexity, it wasn't easy to remove but finally I got it out.

Under the mag lamp I checked for cracks and found none but when I examined the tuning board, I noticed the metal was dull and slightly discoloured.

On the copper side the pattern was all corroded around this area. Now I was getting excited – here was a possible cause of all the strife. What had caused all this corrosion? I doubted that it could be from external sources as this location was too far inside the VCR and was localised.

Back on the component side it didn't take long to find the cause or causes. There were two very small electros, C5020 and C5021 (220µF 6.3VW), which were a complete mess, leaking down onto the SW5001 and SW5002 tuning/tracking tactile switches.

Cleaning them up and replacing the switches was easy; finding small replacement electros was a little harder. Anyway, this effected a complete repair and the unit is now back in service.

Masuda trouble

These days I tend to shudder when I hear the name "Masuda". It's not that it sounds like a Japanese food dish, it's just that it spells T.R.O.U.B.L.E. These sets were originally imported by Brashs and are no longer supported at all.

I feel sure that the reason why there was one on my desk to be repaired was a reprisal by the Boss over the Ms Bell affair – which wasn't an affair and was of course quite innocent.

Anyway the written command on the job card was "Dead – fix"; not even a "please fix".

This was a Masuda T1092 which is an AC/DC 27cm remote control TV from Taiwan, also sold under the name of Akai, Aiko, Hanimex, Tandy and Silver.

The most common problem with this set is the failure of IC402, a custom-made 3-pin 11V regulator block. However, in this instance it was a different problem. F402, a 5A fuse, was actually glowing and there was no sound or picture.

The 11V rail was low and got even lower as it reached the flyback transformer. I switched the set off and started looking for shorts to ground with the ohmmeter but could find none, despite the huge current.

It took a long time disconnecting and measuring backwards and forwards between IC402 and T404. The line output transistor was OK and so were all the connections to the flyback transformer.

I was beginning to actually suspect the flyback transformer of breaking down under load when, more by luck than judgement, I measured D410 FR605 out of circuit to find it was very leaky. I replaced it with an FR607, a 1000V 6A high-speed diode which actually fixed the problem.

However, after the set had been on for only fifteen minutes or so, the diode was amazingly hot to touch. I added another diode in parallel but even then they were still running very hot.

I left the set to soak test but it seemed quite stable and a week later showed no further sign of stress. I checked all the voltages again (11V on the anode and 22V on the cathode), reboxed it and sent it home.

I couldn't help wondering why the diodes, now rated at 1000V and 12A, could still be so hot! No wonder the original didn't stand a chance. What a weird TV!

The easy NEC

With some sets you can't help thinking, "this has got to be an easy fix". The symptoms are clear and logically, the answer has to be equally so. So I thought I had it made when a Thai-built NEC N4850 came in. I think this is an NEC design as the board has PWC3607A printed on it.

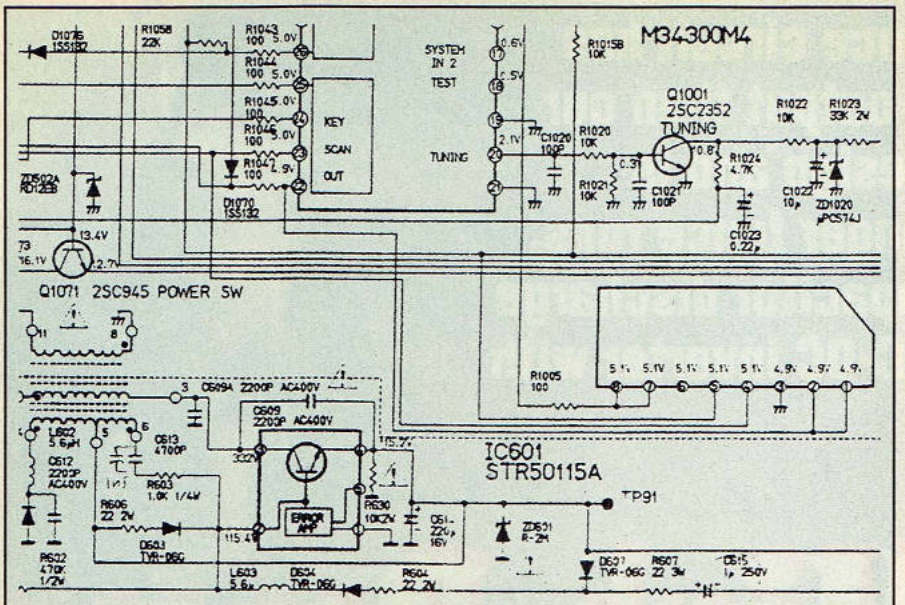


Fig.4: the relevant circuit section for the NEC N4850. The "A" in the type number for IC601 makes all the difference.

Now how easy is this? The fault is: goes dead after one to two hours and if you freeze IC601 (just ever so slightly) it comes good. Probable solution: replace IC601; no need to even look at the circuit. Did that. I ordered the STR50115. It came the next day and I fitted it –piece of cake. Switched on confidently. Goodness gracious me!

A complete new set of symptoms – the set was still dead but the two front LEDs were pulsating very slowly. I must have made a mistake.

Silly me. I checked everything; it was 100% OK.

To be doubly sure, I removed the new IC and refitted the old one. The set came on perfectly and then went off an hour or two later. My conclusion was that I had a duff new one.

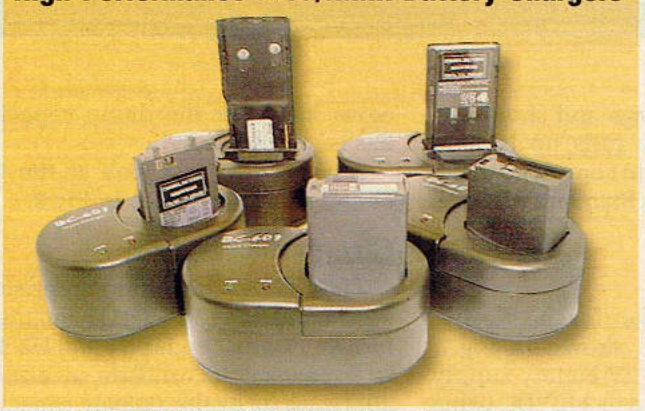
These things happen, so I ordered another. When it arrived, I slammed it in – the set was still dead and pulsating. I compared the new ones with the original – no difference.

It was time to get technical. I dug up the circuit diagram of the set. No clue immediately hit me. There are a couple of modifications to this set, one being to add a .001µF 2kV capacitor across C613 and C612 is upgraded to .0047µF but doing these made no difference.

I finally found the reason. It stares at you so obviously in the circuit and you probably picked it straight away – the answer is, of course, the IC.

It is marked on the circuit as STR-50115A. The A is not always printed on the component but it makes all the difference, and fitting it with new heatsink compound (it gets very hot) fixes the problem completely. **SC**

High-Performance NiCd/NiMH Battery Chargers



FOR 2-WAY RADIO APPLICATIONS, Premier Batteries has introduced its new low-cost high-performance Delta series of battery chargers. Premier's ΔV microprocessor design prevents overcharging and has auto-switching to trickle charge when charging is complete. Adapters are available for the following units: Icom BP157, 160, 174, 173 & 180; Kenwood KNB9, 12, 15, 17; Motorola GP300.

High-Performance Laptop Batteries

FOR LAPTOP APPLICATIONS, Premier Batteries now has a range of direct-replacement NiCd, NiMH and Li-Ion batteries to suit most popular models, including Acernote, Apple, AST, Compaq, Epson, IBM Thinkpad, NEC, Sharp, Texas & Toshiba. These batteries are fully compatible with the original chargers and come with a 6-month warranty.

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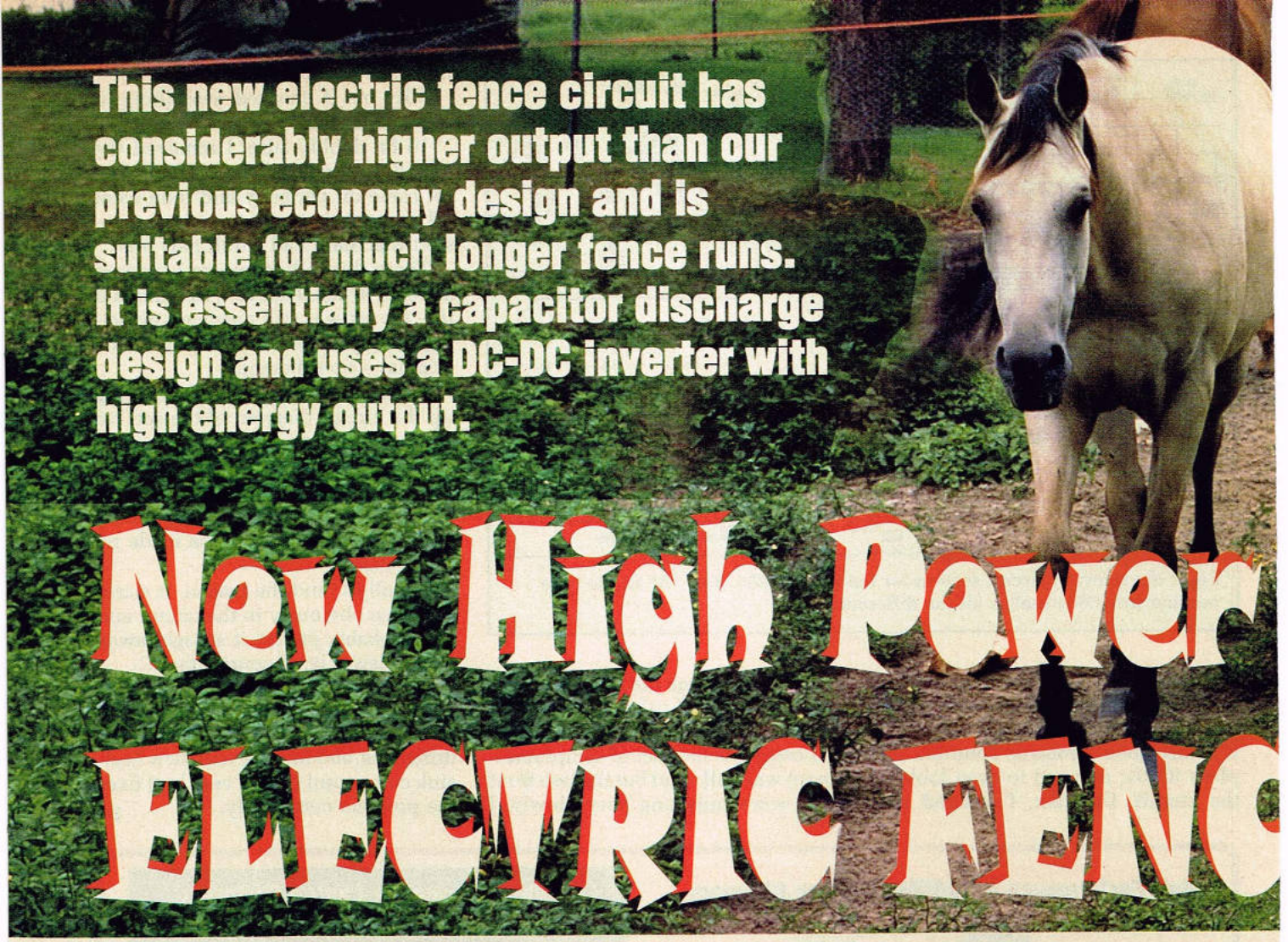


This new electric fence circuit has considerably higher output than our previous economy design and is suitable for much longer fence runs. It is essentially a capacitor discharge design and uses a DC-DC inverter with high energy output.

New High Power ELECTRIC FENCE

ELECTRIC FENCES are widely used on farms to control livestock. They can be set up quickly, are easily moved from place to place and they're much cheaper than permanent fencing.

This new electric fence controller is suitable for fence runs up to about 5km long.

We have mounted the controller in a section of 90mm plastic storm-water pipe fitted with standard end caps. This means it can be made waterproof and it can be attached to a fence post using standard 90mm fittings.

Our previous design was based on a standard 12V ignition coil. While this was a cheap approach it did not have the output for longer fences and was less effective against larger livestock such horses and cattle.

This new design has substantially higher energy storage and should be adequate for fence runs up to 5km long. It is designed to comply with the relevant Australian Standard AS/NZS 3129.

Block diagram

The block diagram for the electric fence controller is shown in Fig.1. This comprises a 12V battery supply which is stepped up to 340VDC using a DC-DC converter. This charges a 7μF dump capacitor.

The charge in this capacitor is "dumped" through the step-up transformer once every second or so using a discharge circuit involving a Triac and pulse timer.

The pulse timer controls both the DC-DC converter and the Triac. It switches off the converter each time it fires the Triac and then switches it on again just after the dump capacitor has been discharged.

Now let's have a look at the full circuit which is shown in Fig.2.

Circuit description

The DC-DC converter comprises a 7555 timer (IC1), Mosfet Q1 and transformer T1 plus diodes D1 and D2. IC1 is connected to oscillate at around 20kHz, as set by the .0039μF capacitor at pins 2 & 6 and the associated 4.7kΩ and 6.8kΩ resistors.

The 20kHz pulses from pin 3 are used to drive Mosfet Q1 and this drives transformer T1 which steps up the voltage and drives a half-wave rectifier consisting of two fast recovery diodes, D1 & D2, connected in series. They are connected in series because their 500V rating is insufficient to allow one diode to be used by itself.

Design by JOHN CLARKE

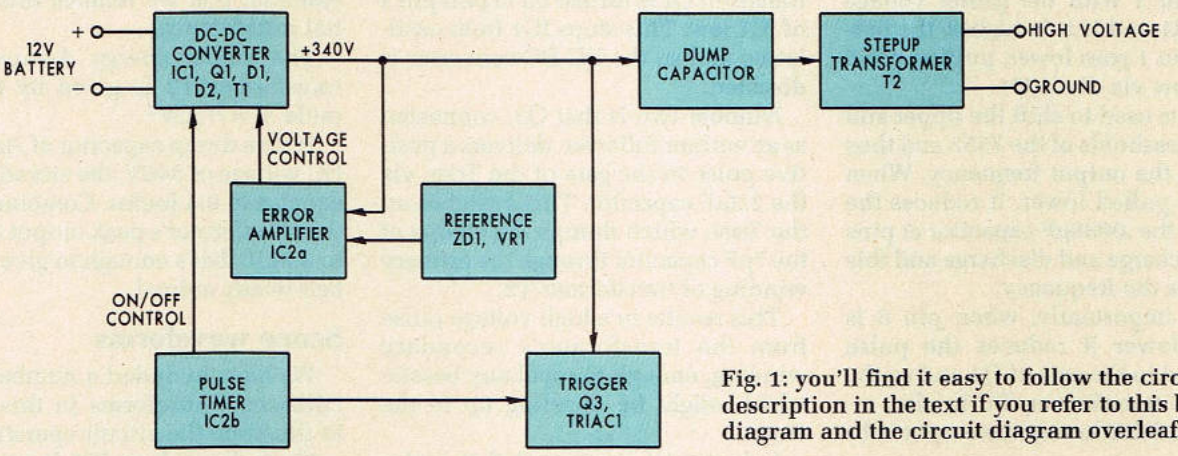


Fig. 1: you'll find it easy to follow the circuit description in the text if you refer to this block diagram and the circuit diagram overleaf.

The half-wave rectifier charges the 7µF 250VAC dump capacitor via the two 220Ω resistors and the primary winding of transformer T2.

The voltage stored in the dump capacitor is monitored by the error amplifier IC2a. The voltage is reduced by the voltage divider consisting of two 1.5MΩ resistors and the 10kΩ resistor and this feeds pin 2 of IC2a.

The non-inverting input of IC2a, pin 3, is connected to trimpot VR1 which taps off the reference voltage from the 4.7V zener diode, ZD1.

The gain of IC2a is set at 28 by the 10kΩ resistor at pin 2 and the 270kΩ resistor between pins 1 & 2. The .0047µF capacitor provides high frequency rolloff above 125Hz.

Modulating the 7555

The error amplifier works in an unusual way to control the DC voltage across the dump capacitor at about

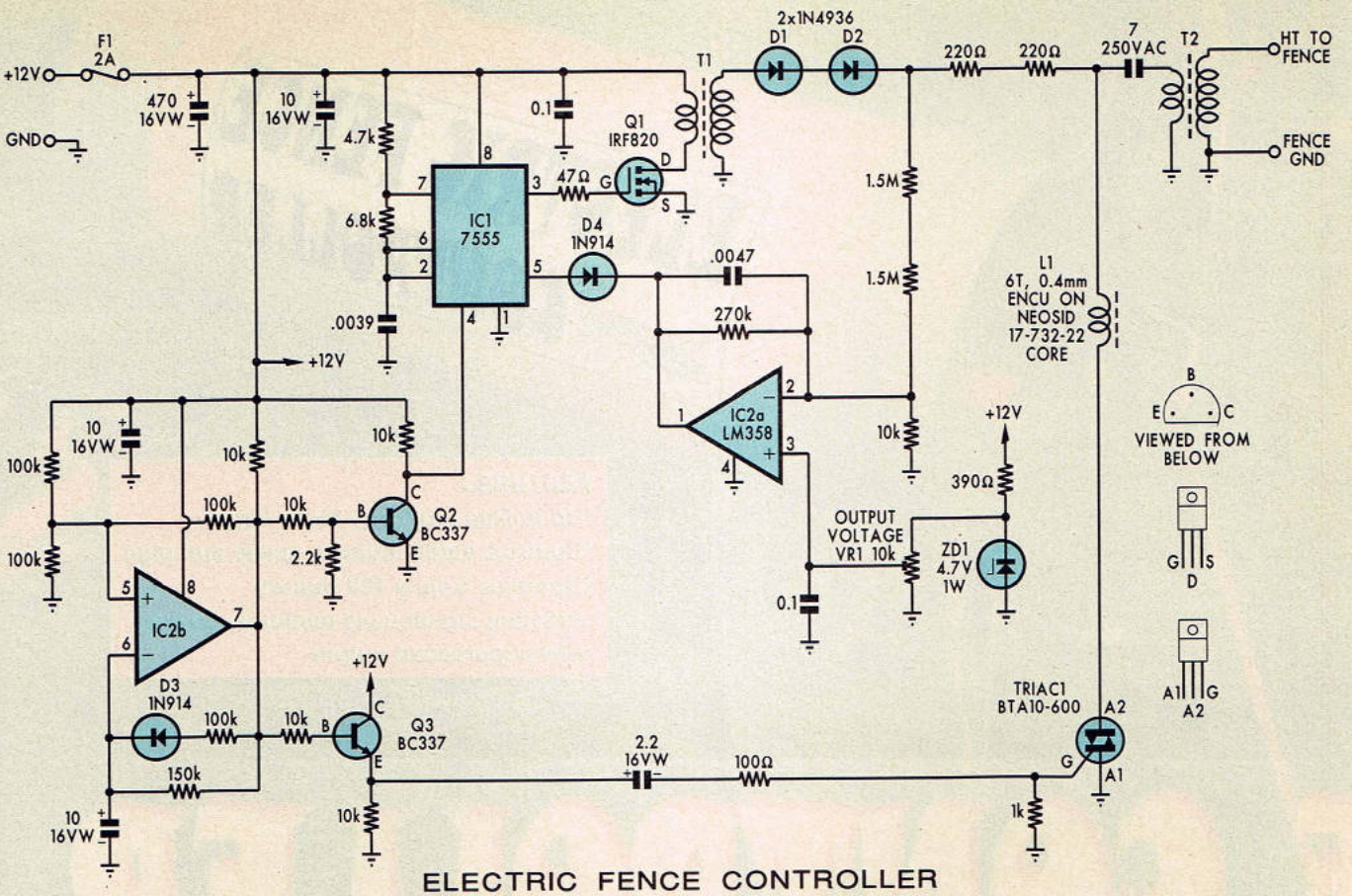


Fig. 2: the circuit diagram shows just how simple the electric fence controller is. Beware the components on the secondary side of T1: they bite!

340V DC. IC2a compares the voltage at its pin 2 with the preset voltage from VR1 and if it is higher, the output at pin 1 goes lower, pulling pin 5 of IC1 low via diode D4.

Pin 5 is used to shift the upper and lower thresholds of the 7555 and thus changes the output frequency. When pin 5 is pulled lower, it reduces the time for the .0039µF capacitor at pins 2 & 6 to charge and discharge and this increases the frequency.

More importantly, when pin 5 is pulled lower it reduces the pulse width fed to the gate of Q1 and so the drive to transformer T1 is also reduced and this lowers the output voltage.

Pulse timer

The pulse timer is a 1.5Hz Schmitt trigger oscillator based on amp IC2b. The 10µF capacitor at pin 6 is charged via diode D2 and the 100kΩ resistor connecting to pin 7 and the 150kΩ resistor from pin 6 to 7.

When IC2b's output goes high, two things happen. Number one is that transistor Q2 is turned on to pull pin 4 of IC1 low. This stops IC1 from oscillating and so the DC-DC converter is disabled.

Number two is that Q3, connected as an emitter follower, delivers a positive pulse to the gate of the Triac via the 2.2µF capacitor. This switches on the Triac which dumps the charge of the 7µF capacitor through the primary winding of transformer T2.

This results in a high voltage pulse from the transformer's secondary winding, enough to repel any beastie which might be nuzzling up to the fence.

Inductor L1 is connected in series with the transformer primary and this controls the rise time of the pulse current from the dump capacitor.

Without the inductor, the very rapid turn-on time of the Triac would mean that a burst of radio interference would be radiated by the electric fence every time it fired.

When you consider how long the antenna (ie, the fence) could be, it was essential that we remove this potential interference.

The actual energy dumped into transformer T2 is given by the formula $E = {}^1/_2CV^2$

With a dump capacitor of 7µF and a DC voltage of 340V, the stored energy equates to 0.4 Joules. Combined with the transformer's peak output of close to 3.6kV, that's enough to give quite a belt to any animal.

Scope waveforms

We have included a number of oscilloscope waveforms in this article to illustrate the circuit operation.

Fig.3 shows how IC1 is turned on and off by the pulse timer. The top trace shows the gated oscillation from pin 3 of IC1 while the bottom trace is the pulse waveform fed to pin 4. Each time the pulse is high, the oscillator output is disabled.

Note that the top trace waveform shows severe quantising error and looks random because the 20kHz os-

cillation is much too fast for the scope's sampling rate which is set by the very low timebase sweep speed of 250ms per division (ie, one sweep takes 2.5 seconds).

Fig.4 shows the charging and discharging of the dump capacitor every 1.5 seconds. The top trace is the waveform across the dump capacitor and as you can see, this builds up to 340V and then is abruptly dropped to zero. Each time it is to discharged to zero corresponds with the positive-going pulse on the bottom trace. This is the waveform at the emitter of Q3 which is used to trigger the Triac.

Fig.5 shows the high voltage waveform delivered by the secondary winding of transformer T2. It was measured via a 100:1 voltage divider and so the peak voltage is 3.6kV.

Fig.6 shows the operation of the DC-DC inverter transformer, T1. The top trace shows the waveform at the

WARNING

Be aware that this circuit produces high voltages and that a large amount of energy is stored in the dump capacitor. If you are not careful you could receive a nasty electric shock. Do not touch the PC board while the circuit is operating. You could get a shock from the dump capacitor, from diodes D1 & D2, the 1.5MΩ & 220Ω resistors, transformer T2 and inductor L1, as well as the Triac; all are charged to the 340V potential.

Naturally, the secondary winding of transformer (T2) can also give you a belt – that's the idea – but it is not as dangerous as the 340V side of the circuit.

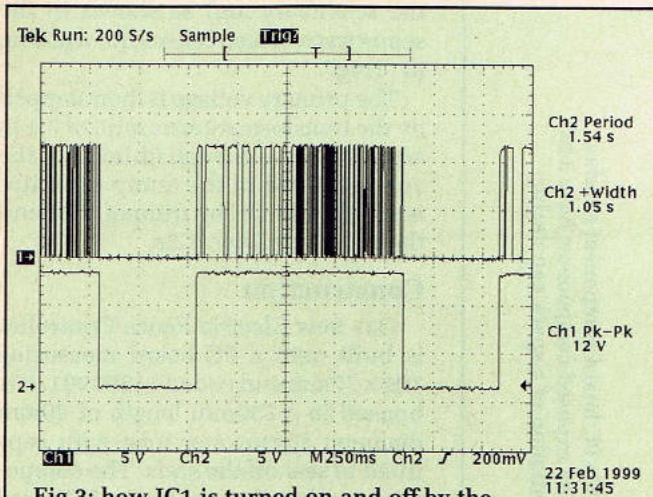


Fig.3: how IC1 is turned on and off by the pulse timer. The top trace shows the gated oscillation from pin 3 of IC1 while the bottom trace is the pulse waveform fed to pin 4.

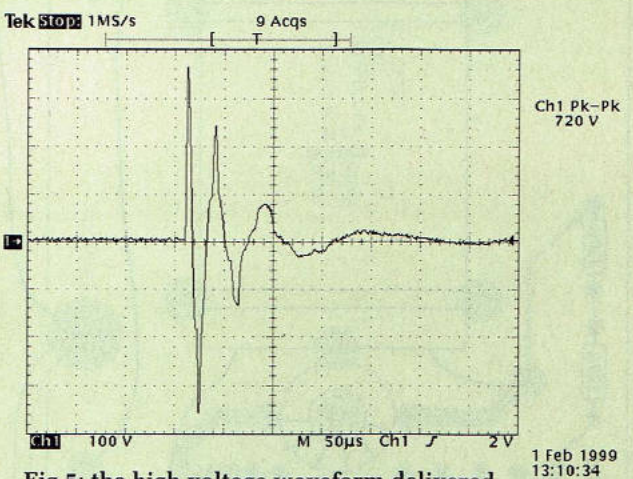


Fig.5: the high voltage waveform delivered by the secondary winding of transformer T2. It was measured via a 100:1 voltage divider so the peak voltage is 3.6kV.

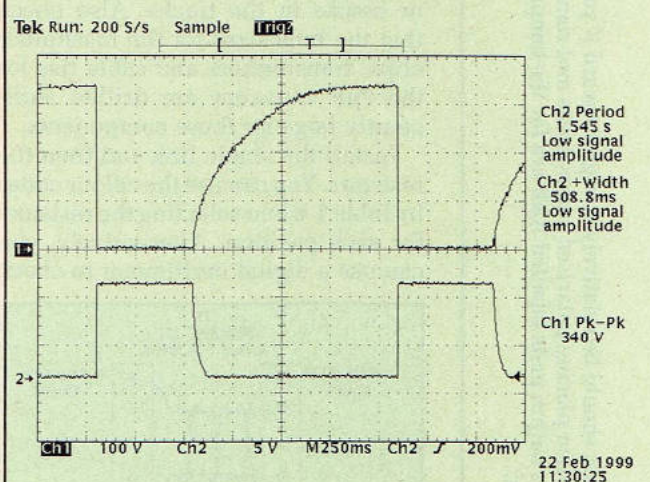


Fig.4: the charging and discharging of the dump capacitor every 1.5 seconds. The top trace is the waveform across the dump capacitor and as you can see, this builds up to 340V and then is abruptly dropped to zero. Each time it is discharged to zero corresponds with the positive-going pulse on the bottom trace.

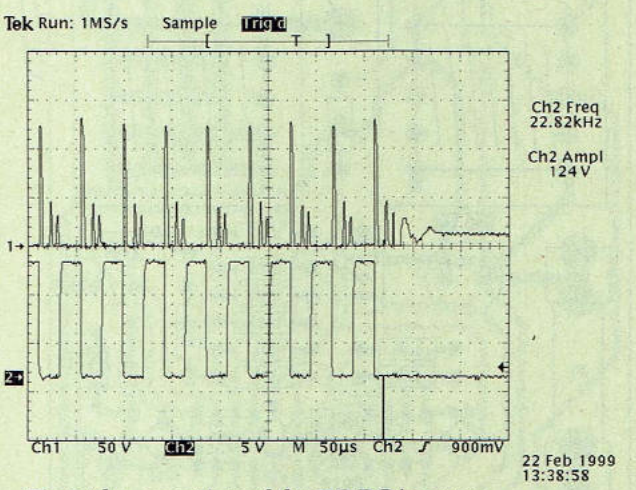


Fig.6: the operation of the DC-DC inverter transformer, T1. The top trace shows the waveform at the drain of Mosfet Q1 while the bottom trace is the driving waveform from pin 3 of IC1, the 7555.

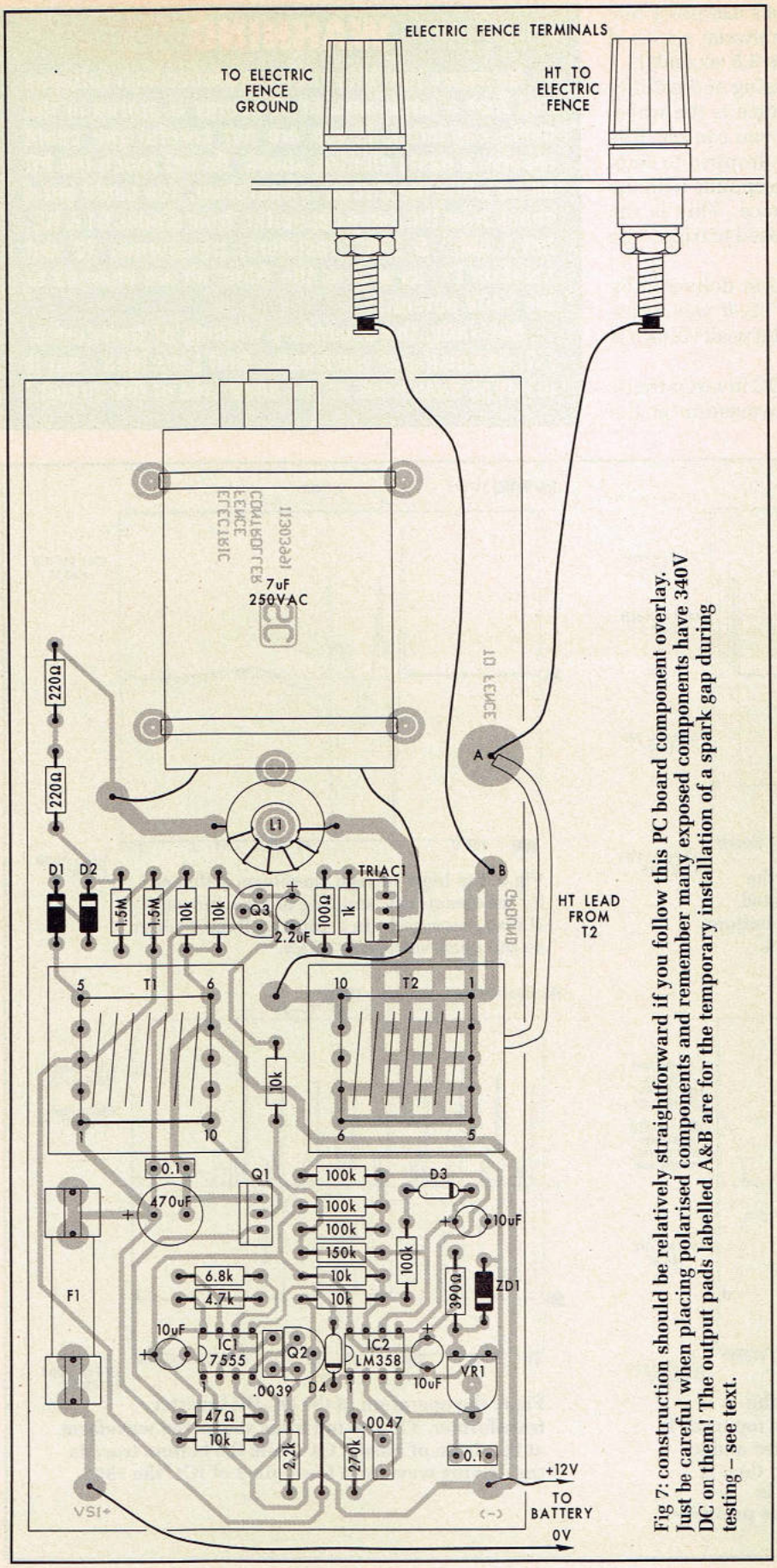


Fig 7: construction should be relatively straightforward if you follow this PC board component overlay. Just be careful when placing polarised components and remember many exposed components have 340V DC on them! The output pads labelled A&B are for the temporary installation of a spark gap during testing – see text.

drain of Mosfet Q1 while the bottom trace is the driving waveform from pin 3 of IC1, the 7555.

Note that the frequency of the bottom trace is 23kHz (nominally 20kHz) and it is essentially a clean pulse waveform. However the top trace shows evidence of ringing at a much higher frequency. What is happening?

The clue is the peak voltage of the waveform: 124V.

What is happening is that each time the waveform at pin 3 of IC1 goes positive, Mosfet Q1 turns on and feeds current through the primary winding of transformer T1. About 20µs later it turns off abruptly and this causes a high voltage (ie, 124V) to appear across the secondary and as shown in the scope trace, it also causes the winding to "ring".

The primary voltage is then stepped by the transformer turns ratio of 3:1 to around 370V although ultimately, the voltage stored in the dump capacitor is set at 340V DC by trimpot VR1 and the error amplifier IC2a.

Construction

Our new Electric Fence Controller is built onto a PC board measuring 189 x 77mm and coded 11303991. It is housed in a 250mm length of 90mm diameter stormwater tube with caps fitted to seal off the ends. The component overlay diagram for the PC board is shown in Fig.7.

You can begin construction by checking the PC board for any shorts or breaks in the tracks. Also check that the hole sizes for the fuseholder clips, transformers and cable ties for the 7µF capacitor are drilled sufficiently large for these components.

Install the single link and then the resistors. You can use the colour codes in Table 1 when selecting the resistors for each position. Alternatively, you can use a digital multimeter to check

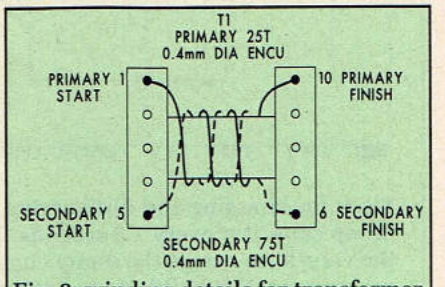


Fig. 8: winding details for transformer T1. This one is the simpler of the two but take care with the starts and finishes and direction of winding.

each resistor value before it is inserted in the PC board. Insert and solder in the PC stakes and the diodes, including zener diode ZD1.

The capacitors can be mounted next, with the exception of the 7µF 250VAC dump capacitor. Note that the electrolytic capacitors must be oriented with the correct polarity.

Be sure to orient the two ICs correctly when installing them and also be careful to put each one in the correct position.

Since they are both 8-pin ICs it is quite easy to put them in the wrong position – they don't work if you do that!

Then insert the two transistors, Mosfet and Triac and trimpot VR1. The fuse clips can be installed and are best mounted with the fuse clipped in place before soldering. Otherwise you might solder the clips in back-to-front and their lugs will stop you putting the fuse in.

The 7µF capacitor is mounted and held in place with two cable ties wrapped around its body and through the PC board. Attach the two wires to the terminals on the PC board as shown.

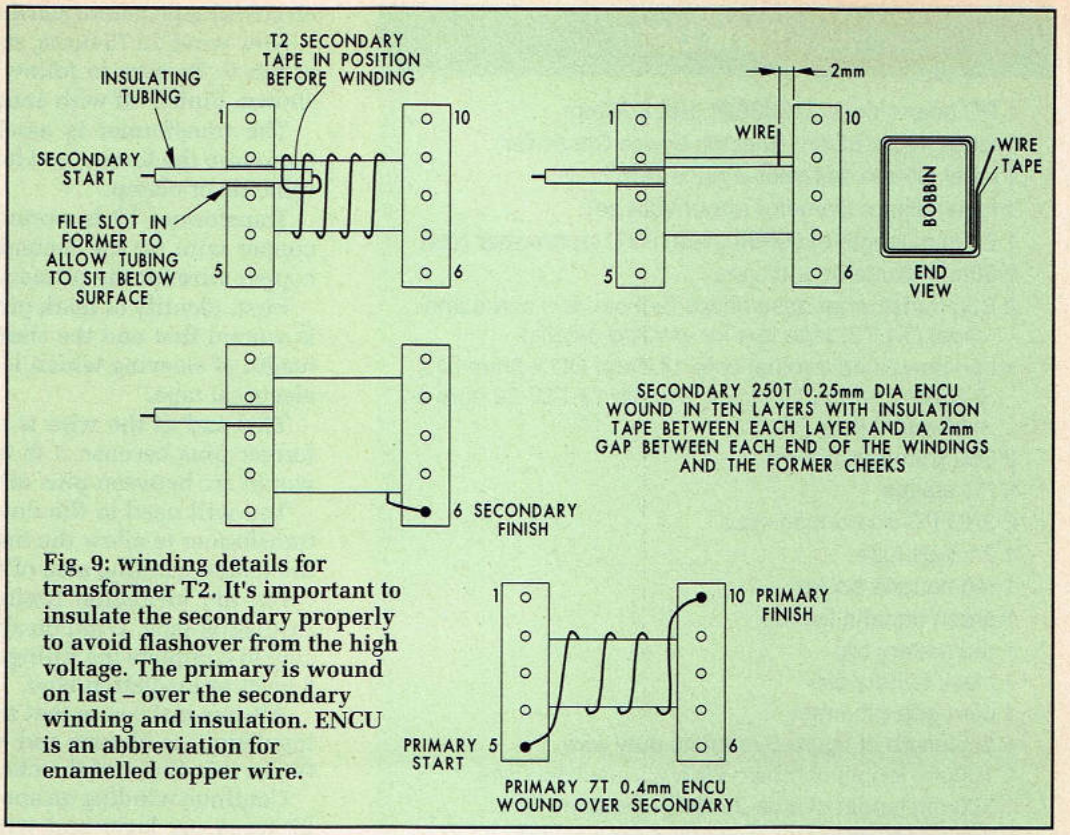

T2 SECONDARY TAPE IN POSITION BEFORE WINDING
INSULATING TUBING
SECONDARY START
FILE SLOT IN FORMER TO ALLOW TUBING TO SIT BELOW SURFACE
1
5
10
6
2mm
WIRE
BOBBIN
WIRE TAPE
END VIEW
6 SECONDARY FINISH
SECONDARY 250T 0.25mm DIA ENCU WOUND IN TEN LAYERS WITH INSULATION TAPE BETWEEN EACH LAYER AND A 2mm GAP BETWEEN EACH END OF THE WINDINGS AND THE FORMER CHEEKS
10 PRIMARY FINISH
PRIMARY START
PRIMARY 7T 0.4mm ENCU WOUND OVER SECONDARY

Fig. 9: winding details for transformer T2. It's important to insulate the secondary properly to avoid flashover from the high voltage. The primary is wound on last – over the secondary winding and insulation. ENCU is an abbreviation for enamelled copper wire.

By the way, depending on where you buy your kit or the parts, the dump capacitor may be 6.5µF or 7µF 250VAC.

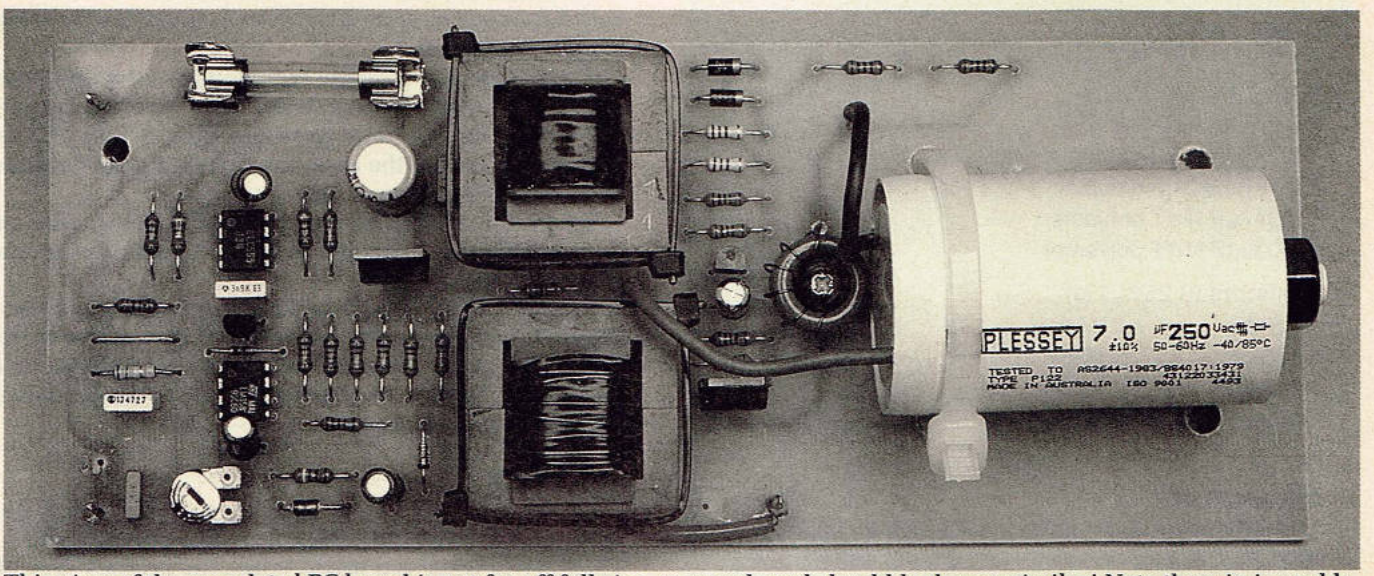
Winding the transformers

Transformer T1 is wound using 0.4mm enamelled copper wire. Fig.8 shows the winding details.

Start by locating pin 1 on the coil former. If the former is not marked then use a pencil to label pin 1 yourself, as shown on Fig.7.

Now strip the enamel insulation off the end of the 0.4mm wire and solder the wire onto pin 1. Wind on 25 turns in the direction shown and terminate the end on pin 10, after stripping off the enamel insulation.

Insulate the winding with a layer of



This view of the completed PC board is not far off full size, so your board should look very similar! Note the missing cable tie around the 7µF capacitor – this was removed and an additional hole drilled (top left) to allow mounting in an alternative case. For stability the second cable tie should be used, even if this means drilling new holes in the PC board.

Parts List

1 PC board, code 11303991,189 x 77mm
1 label, 125 x 50mm (Electric Fence Controller)
1 label, 85mm diameter (Fence Terminals)
1 label, 85mm diameter (Input Voltage)
1 250mm length of 90mm diam. PVC stormwater pipe
2 90mm diameter end caps
2 E30 transformer assemblies (bobbin, two cores and clips) (T1,T2) (see text for winding details)
1 iron powdered toroidal core 14.8mm OD x 8mm ID x 6.35mm, Jaycar LO-1242, Neosid 17-732-22 core or equivalent (L1)
2 280 x 5mm cable ties
6 PC stakes
2 3AG PC board fuse clips
1 2A 3AG fuse
1 red banana socket
1 green banana socket
1 red battery clip
1 black battery clip
1 cord-grip grommet
1 2m length of figure-8 medium duty wire
1 100mm length of brown 250VAC insulated wire
1 300mm length of blue 250VAC insulated wire
1 8m length of 0.4mm enamelled copper wire
1 15m length of 0.25mm enamelled copper wire

Semiconductors

1 7555, LMC555CN CMOS timer (IC1)
1 LM358 dual op amp (IC2)
1 IRF820 500V 3A or P6N60E 600V 6A Mosfet (Q1)
1 BTA10-600 Triac (Triac1)
2 BC337 NPN transistors (Q1,Q2)
2 1N4936 500V 1A fast diodes (D1,D2)
1 4.7V 1W zener diode (ZD1)
2 1N914, 1N4148 switching diodes (D3,D4)

Capacitors

1 470µF 16VW PC electrolytic
3 10µF PC electrolytic
1 6.5µF or 7µF 250VAC
1 2.2µF 16VW PC electrolytic
2 0.1µF MKT polyester
1 .0047µF MKT polyester
1 .0039µF MKT polyester

Resistors (0.25W, 1%)

2 1.5MΩ	1 270kΩ	1 150kΩ
4 100kΩ	5 10kΩ	1 6.8kΩ
1 4.7kΩ	1 2.2kΩ	1 1kΩ
1 390Ω	2 220Ω	1 100Ω
1 47Ω		

Miscellaneous

1 12V 2.4Ah or larger battery; 2 clamps for 90mm conduit; 1-3 2m long galvanised ground stakes; self-insulated timber posts or steel posts and insulators; fence tape, etc.

electrical tape before starting on the secondary.

Now wind on 75 turns, starting at pin 5 and finishing at pin 6. Be sure to follow the winding directions as shown. Finish off with another layer of electrical tape.

The transformer is assembled by sliding the two cores into the former and holding them together with a cable tie or clamp.

Transformer T2 is wound using 0.25mm enamelled copper wire for the secondary and 0.4mm enamelled copper wire for the primary. Fig.9 shows the details.

First, identify or mark pin 1. The secondary winding is wound first and the start is insulated with a 50mm length of sleeving which is held onto the bobbin with electrical tape.

This end of the wire is not connected to the transformer pins because it is the high tension end and it would arc between pins otherwise.

You will need to file down the cheek section of the transformer to allow the insulating tubing to sit flat on the inside winding area of the bobbin.

Fix the insulation tubing in place as shown with insulation tape. Wind on about 10-turns neatly side by side to complete the filling of the first layer. Cover it in a layer of insulation tape.

Always make sure that the wire passes out from the insulation as shown and with a 2mm clearance between winding and the cheeks of the former.

Continue winding on another nine layers, with about 27 turns per layer and with insulation tape between each layer. Terminate the finish of the winding at pin 6.

We must emphasise that the insulation and placement of the winding in the 10 layers is most important, otherwise the transformer will suffer from flashover and ultimately, it won't work. Each layer must be insulated with a layer of electrical tape and be sure to start and end the tape at the top section of the bobbin rather than at the sides. The reason for this is to improve clearance between the windings and the ferrite cores which are slid in place after the windings are completed.

Note also that the wire must not be started or finished beyond a 2mm clearance gap at each end of the winding area in the former.

By comparison with the high voltage secondary, the primary winding is easy. Wind on 7 turns of 0.4mm enamelled copper wire between pins 5 and 10, as shown. Then slide the cores into the former and secure them with a cable tie or clips.

Insert and solder the transformers in place, making sure that they are oriented with pin 1 as shown on the diagram of Fig.7.

Inductor L1 is wound using 6 turns of 0.4mm enamelled copper wire and these are terminated as shown on the PC board. You can secure the toroid in place with a cable tie or with a 3mm screw, nut and plastic washer or a small rubber grommet.

Warning

Before applying power and commencing to test the unit, please heed the warning earlier in this article. Contrary to what you might think, the primary side of the output transformer is in fact more dangerous than the high voltage secondary.

Of course, we would prefer not to get across either!

Testing

Having warned you about the high voltages, we can talk about testing the circuit.

The first step is to wind trimpot VR1 fully anticlockwise. Then apply 12V to the circuit and check that there is 12V between pins 1 and 8 of IC1 and between pins 4 and 8 of IC2.

Switch off power. Temporarily tie pin 6 of IC2b to pin 8 with a 10kΩ resistor. This disables the pulse timer and means that IC1 operates continuously.

Connect a multimeter between ground and the cathode of diode D2 with the meter set to read 400V DC or more. Now switch on the power and adjust VR1 slowly until the meter reads 340V. Switch off and wait for the voltage across the dump capacitor to discharge to below 12V.

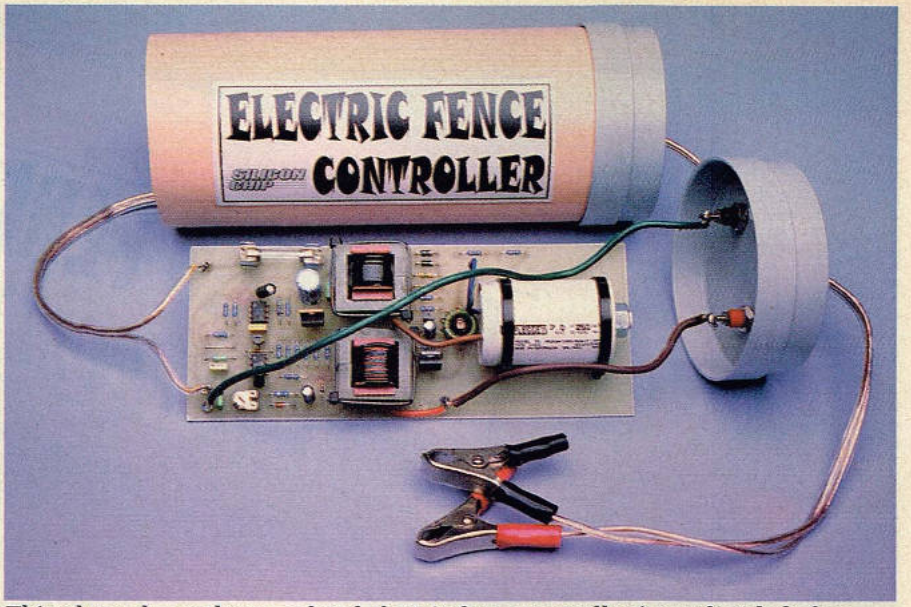
Disconnect the 10kΩ resistor between pins 6 & 8 of IC2. We are now almost ready for the high voltage check and this should be a mere formality if you have been successful to this point.

High voltage check

Don't reapply the power just yet. Instead connect a piece of tinned copper wire between the high voltage terminals on the PC board, ie, between terminals A & B.

Then cut the wire with your side cutters and bend the cut wires slightly apart so that you have a spark gap about 5mm wide.

Now apply 12V to the circuit again and you should get a healthy spark every 1.5 seconds.



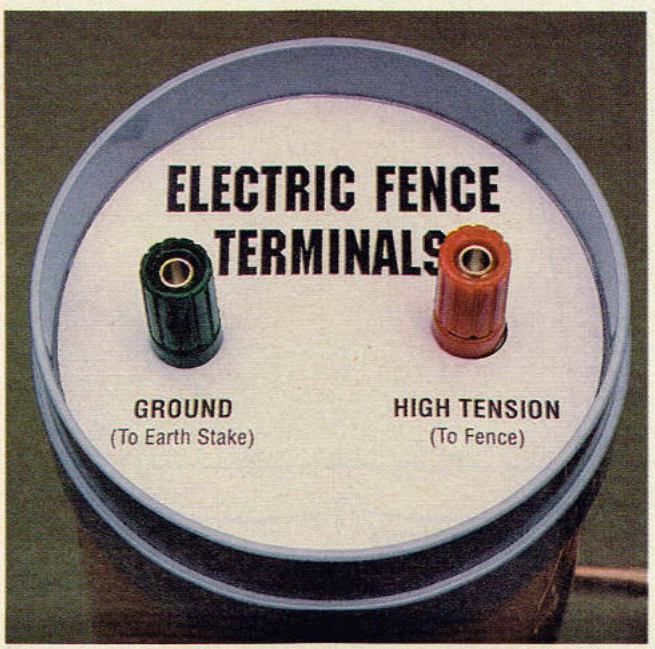
This photo shows the completed electric fence controller immediately before final assembly inside its 90mm PVC stormwater pipe "case".

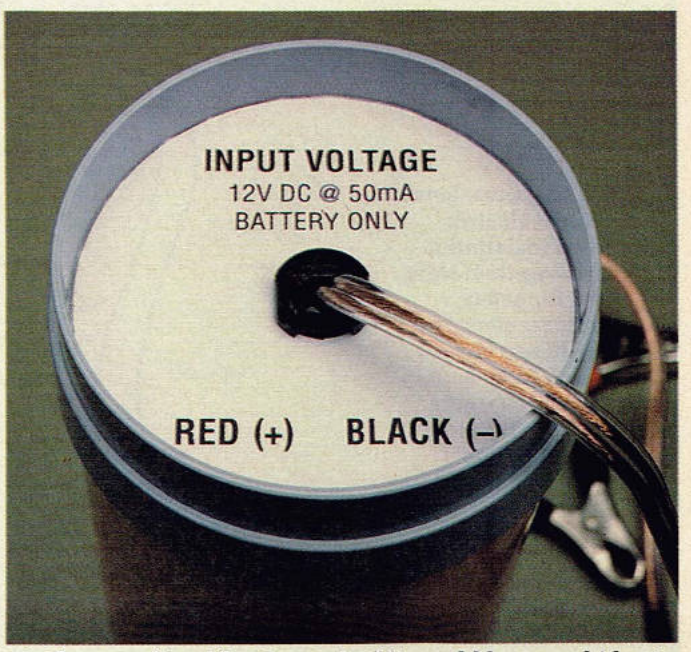
Final assembly

While we built our prototype Electric Fence Controller into a length of 90mm plastic stormwater pipe, an alternative approach would be to house the PC board in a sealed plastic weatherproof box such as one sold by Dick Smith Electronics with catalog number H-2865. Measuring 146 x 222 x 55mm, this box has plenty of room for the PC board and the lid is fitted with neoprene gasket to ensure a water-tight seal.

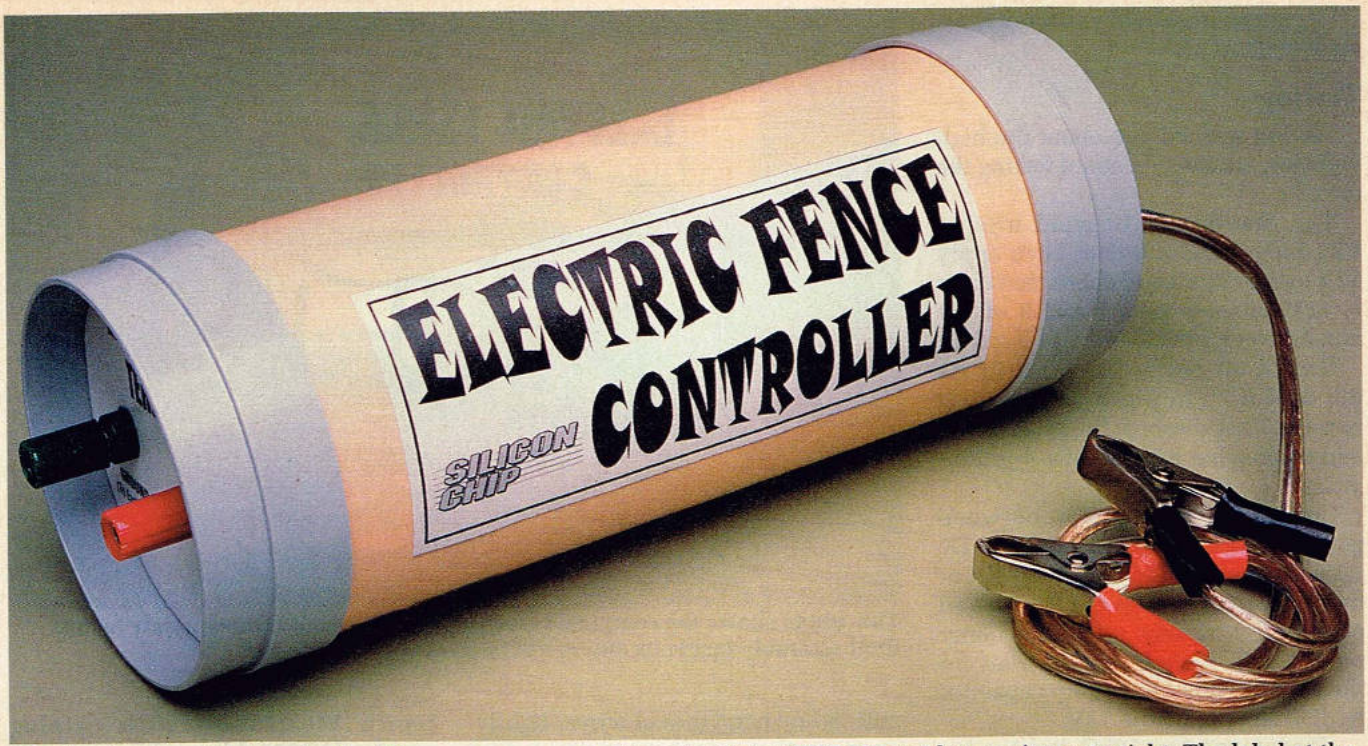
We understand that this box will be included in the Dick Smith Electronics kit for this project.

We have designed a number of labels for the Controller. As with the PC board pattern, they can be downloaded from the SILICON CHIP website, www.siliconchip.com.au





The two end caps in position, complete with labels. If used out in the open (ie without covering) it would be a good idea to apply some silicone sealant inside the cap to waterproof the terminals and (especially) the power cable hole.



Finally, the completed controller. The caps are a push fit on the 90mm PVC pipe and are quite watertight. The label at the battery end states red and black for +12V and 0V: this of course refers to the colour of the battery clips, not the wire! Incidentally, if you don't like the pretty pink pipe and groovy grey caps, they're also available in boring old white.

The first measures 125 x 50mm and has the words "Electric Fence Controller". This can be glued to the pipe itself, as shown in our photos. There are also two 85mm diameter labels, one of which fits inside each end cap. One is labelled "Fence Terminals" and the other is "Input Voltage".

When these are fitted to the end caps, you can drill the two holes for the fence terminals and cut out the hole for the cord grip grommet in the

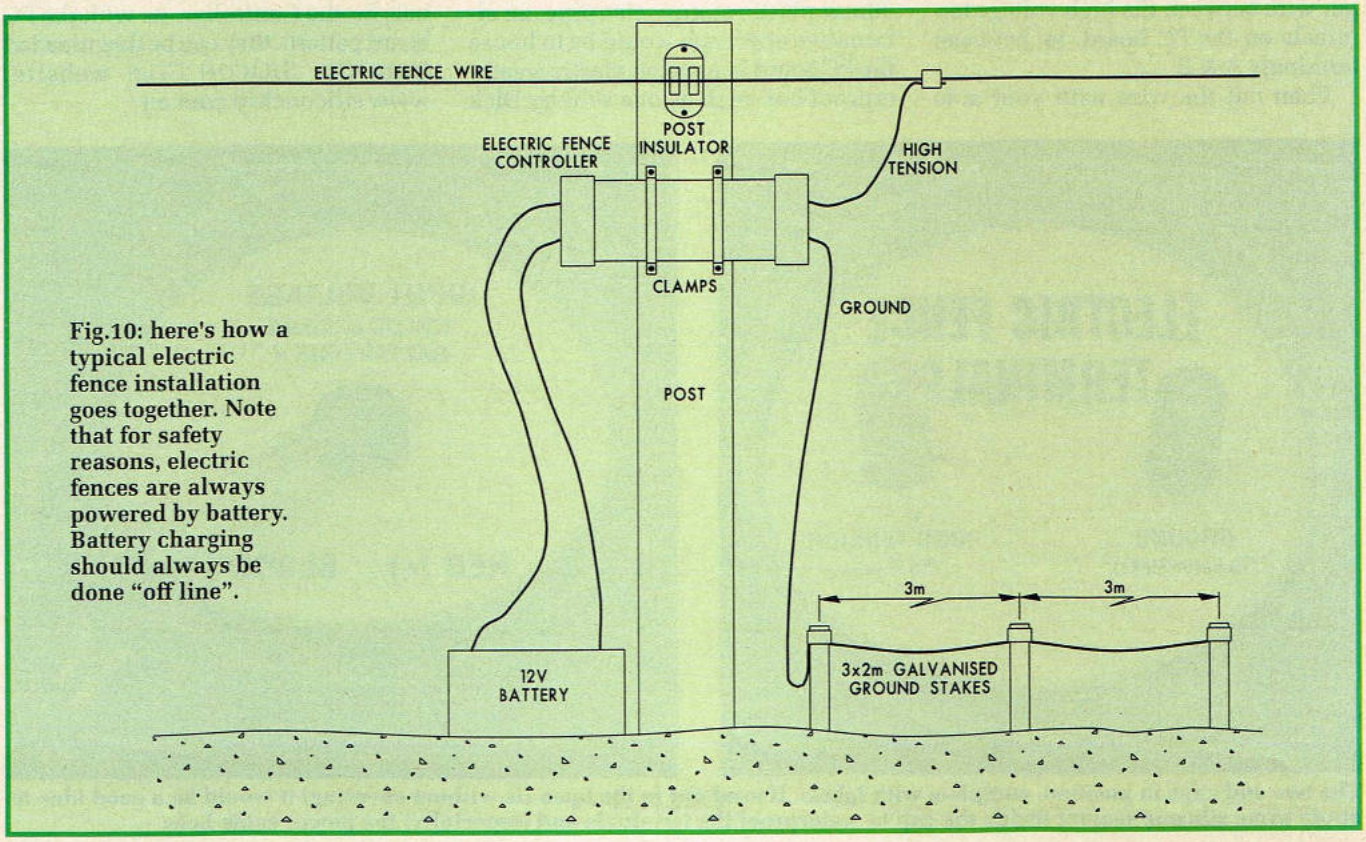


Fig.10: here's how a typical electric fence installation goes together. Note that for safety reasons, electric fences are always powered by battery. Battery charging should always be done "off line".

other end cap. Attach the terminals and connect and solder the earth lead and the high tension lead.

Solder a length of figure-8 cable to the 12V input PC stakes on the PC board. Feed the end of the cable through the stormwater pipe and the hole in the end cap and then place the assembled PC board into the tube.

The figure-8 cable is anchored in the end cap using the cord grip grommet. Both end caps can then be fitted onto the tube. To stop the board rattling inside the tube, you can wrap it in some foam rubber or bubble-wrap.

Attach the battery clips to the figure-8 cable, using red for positive and black for negative. Don't get these back-to-front otherwise you will blow the fuse. Then give the system another test, with the spark gap wires still across the output terminals.

Does it still give a nice, juicy spark? Yep? Good. Now you can remove the spark gap wires before final assembly (the fence won't operate satisfactorily with the spark gap left in place).

Use some silicone sealant to waterproof all joints around the end caps and wire entry point.

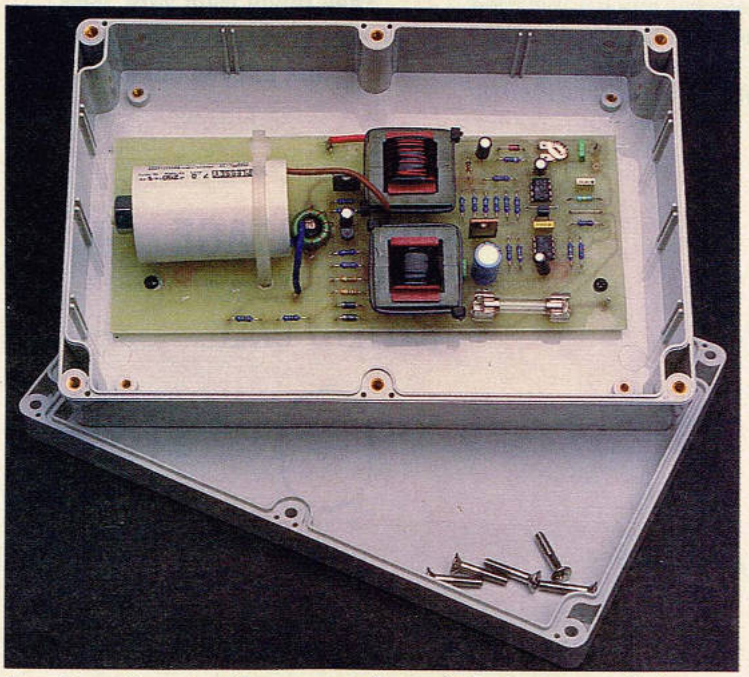
ELECTRIC FENCE CONTROLLER

SILICON CHIP

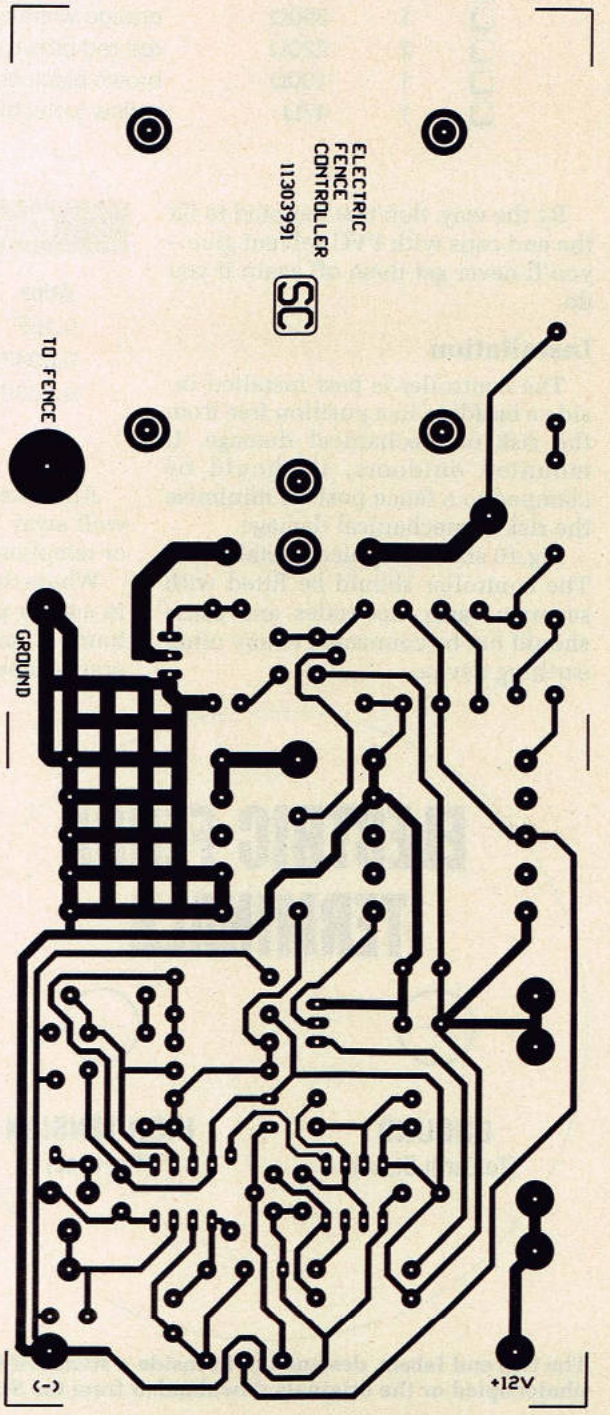
Above: the label we prepared for the electric fence. It was glued onto the PVC pipe with spray adhesive.

Right: the full-size PC board pattern for those who wish to make their own. You can also use this to check commercial boards for etching defects.

All three labels and the PC board pattern are available for downloading from the SILICON CHIP website, www.siliconchip.com.au



An alternative mounting approach would be to use a sealed weatherproof case such as this one from Dick Smith Electronics. As luck would have it, the holes for one of the capacitor-holding cable ties line up perfectly with the mounting points moulded into the case. For security, another cable tie should probably be used, necessitating a new pair of holes drilled in the PC board.



Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
2	1.5MΩ	brown green green brown	brown green black yellow brown
1	270kΩ	red violet yellow brown	red violet black orange brown
1	150kΩ	brown green yellow brown	brown green black orange brown
4	100kΩ	brown black yellow brown	brown black black orange brown
5	10kΩ	brown black orange brown	brown black black red brown
1	6.8kΩ	blue grey red brown	blue grey black brown brown
1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
3	2.2kΩ	red red red brown	red red black brown brown
1	1kΩ	brown black red brown	brown black black brown brown
1	390Ω	orange white brown brown	orange white black black brown
2	220Ω	red red brown brown	red red black black brown
1	100Ω	brown black brown brown	brown black black black brown
1	47Ω	yellow violet black brown	yellow violet black gold brown

By the way, don't be tempted to fix the end caps with PVC solvent glue – you'll never get them off again if you do.

Installation

The controller is best installed inside a building in a position free from the risk of mechanical damage. If mounted outdoors, it should be clamped to a fence post, to minimise the risk of mechanical damage.

Fig.10 shows a typical installation. The controller should be fitted with separate earth electrodes and these should not be connected to any other earthing device.

Capacitor Codes

Value	EIA	IEC
0.1µF	104	100n
0.0047µF	472	4n7
0.0039µF	392	3n9

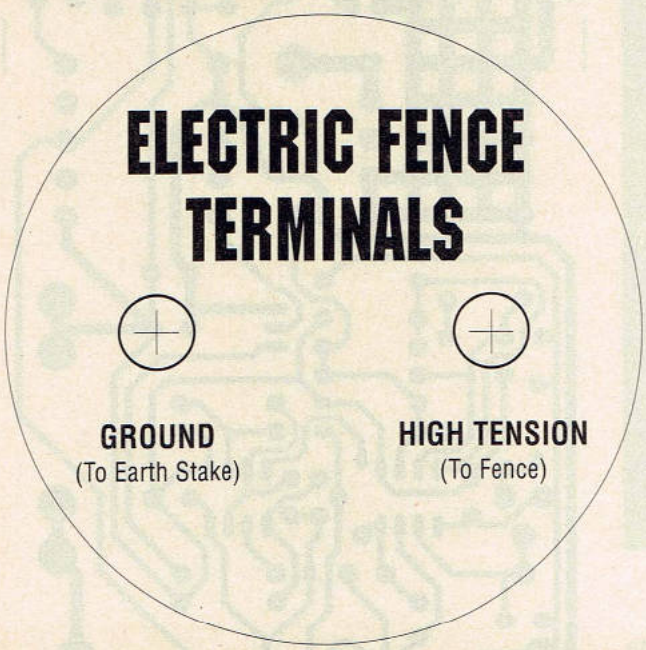
All fence wiring should be installed well away from any overhead power or telephone lines or radio aerials.

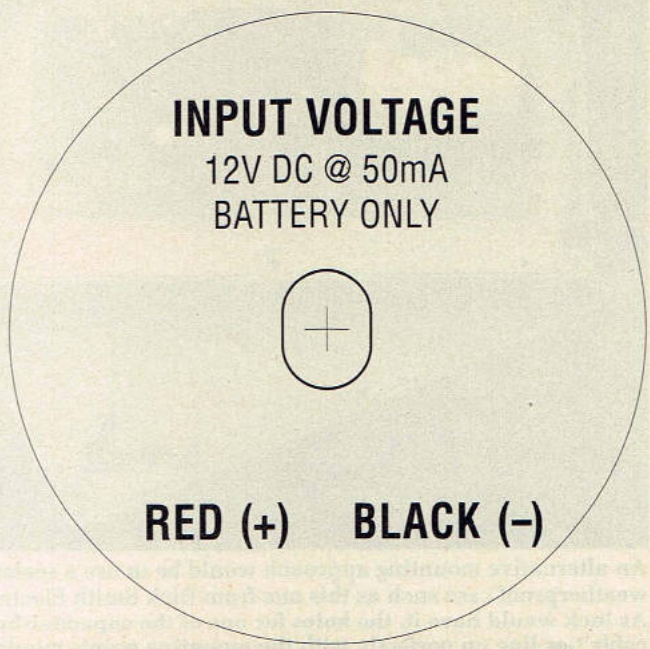
Where the electric fence is installed in such a position that people might touch it and it is not using white or orange tape, it should be identified by suitable signs clamped to the wire or fastened to the posts at intervals not exceeding 90m.

Such signs should bear the words "ELECTRIC FENCE" in block letters no less than 50mm high. **SC**

COMING NEXT MONTH

We have developed a number of testers to check the output from this, or any other electric fence. They range from very, very simple to very simple – and all are easy to build.





The two end labels, designed to fit inside a standard 90mm PVC (stormwater) pipe end cap. These labels can be photocopied or the originals downloaded from the SILICON CHIP website, www.siliconchip.com.au

MAILBAG

LED ammeter not applicable in all cars

I read with great interest about the design and construction of an electronic ammeter for use in motor vehicles, described in your January 1999 issue, utilising the return "earth" lead to the battery as the current shunt.

I am satisfied with the concept in principle and was in the process (a few years ago) of developing a similar instrument. At that time, it was my intention to utilise an analog meter for the display. As a result of your magazine article (reactivating my interest), I decided to use a digital multimeter to measure the voltage drop across the earth lead of my aged Renault 16TS. However, on further investigation of the wiring layout of my car (and I suspect it may also apply to many modern cars), I was prompted to write this letter.

There are several potential problem(s) that the car owner may be presented with and which I am facing now. I feel that you will be as surprised as I was!

(1). The starter motor circuit comprises two heavy current carrying cables between the battery positive terminal and the starter motor solenoid, and the battery negative terminal and the engine block. The heavy cables are there to minimise power loss when starting the engine.

(2). The alternator/battery charging circuit consists of the line between the alternator output terminal and the battery (which generally makes use of the high current capacity cable for part of its return), and the high current (return of starter motor current) cable between the engine block and the battery negative terminal.

(3). The auxiliary (discharge) circuit for lights, fans, radio, engine controls, etc is taken from the positive battery terminal to feed the auxiliary items and there is a cable return to the body of the motor vehicle and there is another return wire directly to the negative terminal of the battery from the chassis.

As I see it, placing the ammeter across the heavy cable connecting the battery negative to the engine block will only monitor the current being supplied by the alternator. Some of that current may be used by the auxiliary (discharge) circuits, with the remainder being delivered to the battery as charging current. However, the input (charge) current to the battery will be unknown.

Furthermore, the value of any battery discharge which takes place whilst the alternator is not charging when the engine is not running also is not able to be measured.

In summary, in accordance with the discussion and instructions contained in your ammeter article and the physical wiring layouts possibly employed in motor vehicles, only the current being supplied by the alternator is being measured, not the current charging or being discharged from the battery.

Therefore, the ammeter will always show a yellow or a green, as it can never show a discharge under normal operating conditions. Of course, alternator failure by shorted diodes and failure of the starter motor solenoid to open the starting circuit would show a discharge (dramatic).

Fortunately, as my motor vehicle is not new, I am not restricted by a car manufacturers' warranty agreement. I will be able to rewire all the return circuits directly to the block of the engine, and so create the single charge/discharge circuit path, via the heavy cable to the engine block that is required for your ammeter.

R. Smith,
North Melbourne, Vic.

Comment: as you have shown, this circuit is not practical for cars with split charging circuits. And while it may be practical to modify the wiring of older cars to provide a common battery return cable, we would not recommend it for newer cars, particularly those which may still be under warranty.

Converting PC power supplies

Prior to your article in the December 1998 issue on making use of old PC power supplies, I had converted a number of PC power supplies for model engineers' use. With reference to those supplies requiring a load across the +5V output, I found a 12V automotive tail or stop lamp to be successful.

Initially I tried a 6V lantern lamp but the fan merely starts then stops, although that was suitable for my purpose. After reading your article I tried a 47Ω 1W resistor without success although occasionally I got a fan that would just "kick". All supplies tested OK with the auto lamp.

You invited suggestions for the use of the +5V output. I have several uses. I have two attachments for my lathe which are made from the "works" of old 4.8V cordless drills. Either are used in the tailstock as drill speeders (small drill bits) or for "milling" centres for accuracy. One is used in the toolpost as a drilling or milling attachment. I find they will also run quite satisfactorily on the +12V output.

I have what is virtually a miniature bench grinder for regrinding small drill bits, PCB drill bits, etc. That utilises the +5V output. A 6V battery operated slot car set has been another application (under adult supervision). Some converted power supplies are in use for low voltage lighting (12V) on lathe, drilling and milling machines, replacing 240V lighting for safety.

I run both 12V PCB drills and engravers off the +12V output and occasionally use the +5V output when I require a lower speed for various reasons.

B. Smith,
Hoppers Crossing, Vic.

TV services in the Newcastle area

I'm writing to correct one or two points in J. Lowe's letter on page 13 of the January 1999 issue. This was regarding TV services in the Newcastle/Lower Hunter area.

For a start, I am in full agreement that it was a hare-brained idea to allocate VHF TV channels 3, 4 and 5 in

Mailbag – continued

what is universally recognised as FM radio bandwidth but this was done in the 1950s and there was no consideration of a future FM broadcasting service back then, even though some experimentation had been going on just prior to the commencement of TV broadcasting in this country.

Now for some clarification. Firstly, VHF channel 5A was by no means a new channel in 1987 (when Mr Lowe moved to Heatherbrae). Ch.5A was, together with channels 0 and 11, created in 1957/58 by the then broadcasting authorities when they realised that the 10-channel system they started with in 1956 would prove inadequate to handle future TV services once regional stations began to be established.

The shifting of ABC service ABHN from Ch.5 to Ch.5A was made necessary due to the impending commencement of community broadcaster 2NUR-FM in 1978. The channel shift occurred around the end of 1976 or early 1977. The commencement of UHF transmission on Ch.48 started just prior to Christmas 1991 and has operated in tandem with the existing VHF service on Ch.5A ever since.

Meanwhile, NBN stubbornly continues to refuse to shift to UHF CH.51 and has done so ever since the commencement of aggregated TV services on New Year's Day 1992, and even before then. It would be of enormous benefit to those operating community FM broadcasting stations for NBN to finally make the move and vacate Ch.3 for Ch.51. The reason is that TV Ch.3 spans the VHF band from 85MHz to 92MHz, overlapping the bottom end of the FM band by 4MHz. In that space there is room for twenty FM channels, including four in this region alone!

Many of the community broadcasters are what are classed as "aspirant" stations. Some are on air now on temporary frequencies, awaiting a full-term licence and a permanent allocation. Others are on air with a more-or-less permanent frequency but still await a full-term licence. And there are those who are still to commence broadcasting and are at various stages of getting their studio equipment together and are awaiting either a temporary or permanent frequency to operate.

For stations such as these, the clearance of NBN from Ch.3 to the UHF band will mean a freeing-up of the FM band and they can look forward to being allocated a frequency to serve their community or communities at long last.

NBN's decision to stay on VHF Ch.3 has ramifications that stretch far beyond its own service area. It affects allocations from south of Gosford right through to north of Taree. Even though NBN's signal may not be picked up in those areas, their signal may still cause problems for FM broadcasters operating in those regions on frequencies in the 88-92MHz bandwidth.

Official pressure should be brought to bear to compel NBN to move to the UHF channel which has been set aside for them, so that the FM broadcasting sector, particularly community broadcasting, can grow and flourish.

N. Forbes,
Stockton, NSW.

Thermocouple adaptor for DMM kit

I am just in the process of building the thermocouple adaptor kit for a DMM, as described in the December 1998 issue. I note that a source for a panel connector could not be located. I have just purchased one from Farnell Electronic Components. They have several different types. I selected a panel clip mount, part no 708 6386, at about $6.50 each. They also have a good range of thermocouples.

M. Abrams,
Melbourne, Vic.

Panel production article very worthwhile

At last somebody has written an article that shows how to produce good looking front panels! We have been using a similar process to that described in the February 1999 issue, here in the Mechanical Engineering Department to produce front panel labels for electronic equipment, and I thought you might be interested in it.

We use a product called Lectracopy. This is a self-adhesive polyester film designed for use in laser printers. It is available in clear gloss and clear matt. We use the clear matt as we feel the toner sticks better to it. All we have to do is drill the panel, print out the label on Lectracopy, stick it on and trim the holes with a scalpel. We used to coat them with clear lacquer but have discovered it can tend to flake off, so in future we will put an unprinted label on top. The toner is quite robust by itself, however.

As the film is clear, the panel is simply painted in whatever colour(s) the text is to come out in. It is also possible to mount LEDs behind it to make highlightable legends.

One point to note: the adhesive does not work very well on textured plastic. This is where spray adhesive might work well.

The product may also be known as Hydrocopy. We buy it from an art supply store called The Drawing Room, PO Box 880, Christchurch NZ, Phone 64 03 366 0033.

Julian Phillips,
University Of Canterbury, NZ.

Eliminating the "glue spray" stage

We use a similar system for making some front panels as you describe in the February 1999 issue but we eliminate the messy 'glue spray' stage by using computer paper that has a peel-off backing. This is similar to the label sheets except the label covers the whole A4 sheet. The sheets are made by JAC and available from most suppliers quite cheaply. Use these sheets in the single-sheet feeder slot on the laser printer and you should save yourselves a lot of time and unpleasantness using the sprays.

J. Williams,
Nathan, Qld.

Good appliances being thrown out

Picking up on what S. Clavan, Black River, Qld., mentioned on page 9 of the December 1998 issue, I can vouch for the fact that disposal of unwanted and faulty (occasionally perfectly OK and working) appliances and technology is alive and well here in NZ as well.

I am continually amazed at the items

that not only private individuals throw away, but large corporations and businesses as well. It is a sad fact that in today's society, the cost of servicing some of these items is far beyond their value, even though they may be only a few years old. Unfortunately, the prices often quoted at service departments often scare people away from having reasonably good appliances fixed.

Having said that, I wonder what happens to old back issues of SILICON CHIP that people don't want any longer. Do they end up in a landfill somewhere? I would be grateful to receive any back issues that someone no longer wants and if they are mailed to me I will refund the postage if required. In addition, can anyone help me with a user-friendly shareware CAD program specifically for doing PCB track layouts?

S. Williamson, Post Box 1462, Hamilton, New Zealand.

Testing remote controls

I read the article on a Remote Control Tester in the February 1999 issue with interest and thought I might offer an alternative, with some of my tried and trusty secrets to remote control resurrection. Most technicians' workshops have a remote control sensor from an old Akai VS2, VS3, VS4 video lying around. These were a clip-on unit that fitted to the front of these VCRs. If you remove one from an old recorder there will be a plug with three wires, red, black and yellow.

Simply cut off the yellow wire (not used), connect red to the + side of a 9V battery and the black to the negative. You then have a cheap tester, basically junk that acknowledges on any remote control via a red LED. Just disconnect the wires when not in use.

Tip 2: Rubber pads on remote controls lose conductive material on the most-used buttons. Clean them with methylated spirits and then coat the contact surface of the rubber pad with paint from demister repair kits. This is a conductive paint for bridging breaks in the wires of demisters on car rear windows (available from auto stores). It works very well and the bottle can be resealed and used again, unlike the repair kits for remotes that have recently been brought out, which use conductive 2-pack glue.

Tip 3: I have repaired many pads with rubber cement, as used in bicycle or car inner tube repair kits, even when completely separated from the rest of the remote pad. It has got to be better than putting a switch in the middle of the remote!

John Macey, Traralgon, Vic.

22.5V batteries available

On page 31 of the December 1998 issue reference was made in the Serviceman's Log to the AS-100D multimeter and its 22.5V battery being no longer obtainable. I have checked with WES Components in Ashfield NSW and they stock a Varta 22.5V battery described as similar to a 9V transistor battery size but with its terminals at either end. The code is V72PX; cost $14.95. Phone (02) 9797 9866. I hope this is of some help.

Brian Mullin, Tindal, NT.

Don't run network cables near 240VAC

The article on computer networking in the February 1999 issue, whilst basically sound, unfortunately appears to not cover practicalities, such as use of existing equipment, which in most cases would be stand-alone systems and the necessity to route cables in a sensible and work-like manner.

Many small businesses do not need workstations as such but need the flexibility of reaching for and/or transferring data between PCs – peer-to-peer gives operators the advantage of being able to use all computers in the network as though they were combined into one large unit.

Also it is good to have the ability to use lesser or older computers for data storage and for duplicate data storage for backup – plus the ability to keep a system up, should any one PC go down and need service. I subscribe to multiple computer installations, networked so that no matter what the drama, at least a workable system can be kept operational.

The area of cabling is also of concern, especially where the article to a degree condemns the use of coax but in fact highlights the importance of installing cabling in a manner where it is mechanically protected from damage. Too often cable is that unnecessary item that has to be run from point to point and ends up strung up like so much washing line!

Cable routes deserve careful planning, to avoid the necessity in the future of tracing them for damage caused by the wrong choice of path in the initial installation. In other words, they should not be in positions where they can be walked on, jammed in doors or windows and so on.

Lastly they should not be run in cable ducts with 240VAC power cables or taped to existing extension or other power supply cables running to the PCs – few network hardware and software packages include these instructions and the unwary installer quite often chooses power cable routes as being suitable pathways for network cables.

As one who has been in the proximity of a loose coax cable when a milkshake machine blew up in the next room and caused a power failure, the resulting audible violet spark at the cable end was quite spectacular. Subsequent checking showed that the network cable had been run along and taped to the 240VAC power cable and to the PC power cables of the computers on the network.

On enquiring as to how many network cards the service station and fast food outlet had lost, the reply was enlightening; "We usually have to send at least one a month for service". Further enquiry as to how and when, revealed that nearly every time there was an electrical failure causing fuses to blow and some piece of equipment fusing, there was also a failure of a network card.

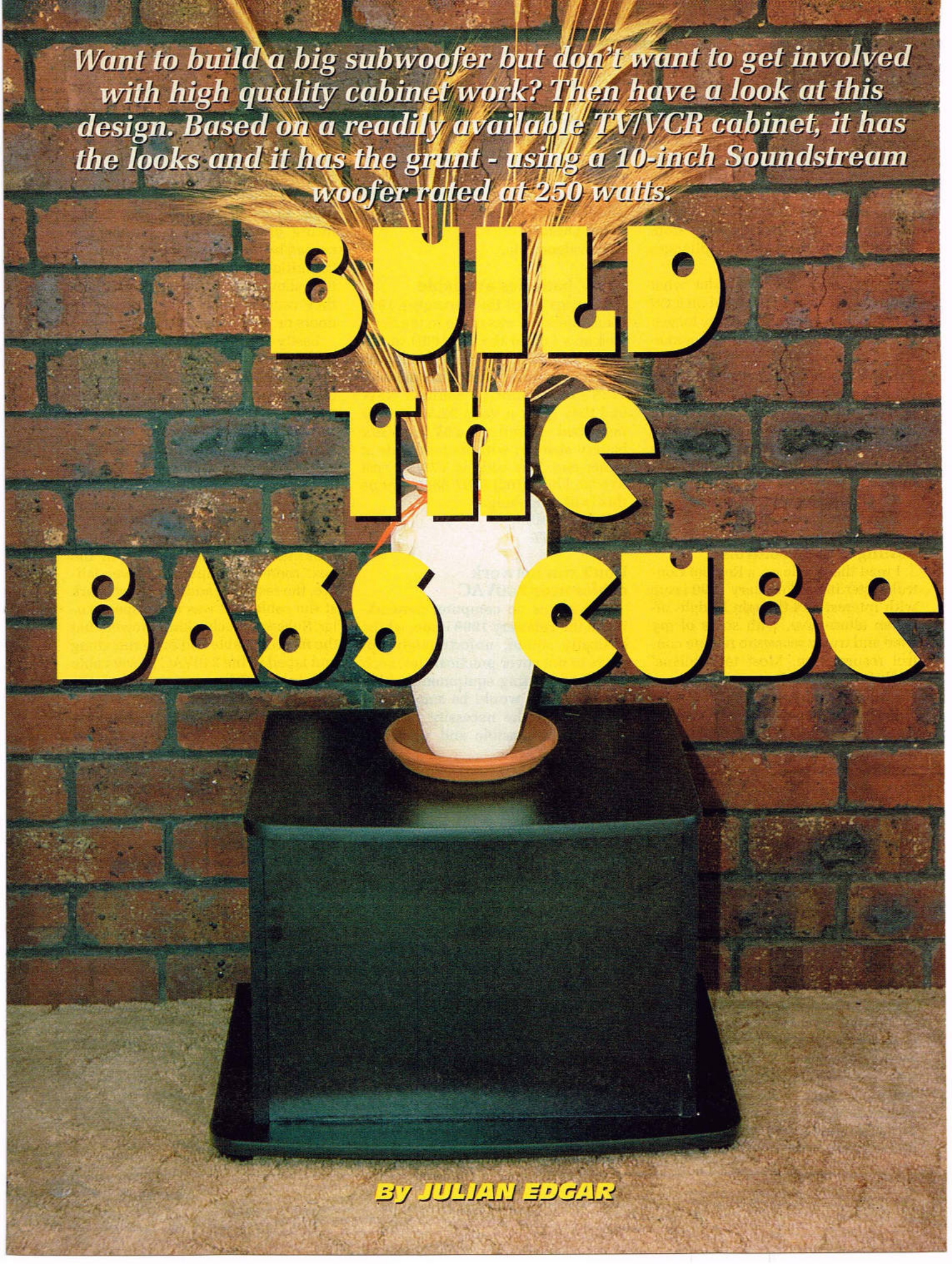
After looking at the total system, the lessee of the service station had a new power sub-board installed to supply the computer network, printers and ancillary bits only and I re-ran the network cables to isolate them from possible powers surge influences.

No more card failures occurred and certain strange glitches to which the computers were prone also disappeared, so the message is clear: keep cables clear.

Jim McCloy, Muswellbrook, NSW.

Want to build a big subwoofer but don't want to get involved with high quality cabinet work? Then have a look at this design. Based on a readily available TV/VCR cabinet, it has the looks and it has the grunt - using a 10-inch Soundstream woofer rated at 250 watts.

BUILD THE BASS CUBE



By JULIAN EDGAR

UNLIKE OUR compact Bass Barrel featured in the August 1997 issue of SILICON CHIP, the Bass Cube is designed to deliver high power. It will really liven up the low bass in even the biggest lounge rooms.

You won't have to apologise for its appearance either because it is based on a readily available commercial product.

Best of all, you won't need to go far to buy the enclosure – it's available for under $50 from all Big W stores, where it masquerades as the Economy Video/TV Cabinet!

OK, you still have to do some woodworking to convert it to the Bass Cube but this is quite straightforward. And because it's based on a commercial cabinet, you should have no problems at all when it comes to obtaining a high-quality finish.

The Bass Cube uses a Soundstream Rubicon 10-inch (250mm) subwoofer with a maximum continuous program power rating of 250W. That's a serious amount of power in anybody's language so it will really deliver the grunt.

This driver uses a 4-layer voice coil with a Kapton-epoxy former which is 50mm (2 inches) in diameter. The woofer has a vented pole-piece to provide forced-air cooling, while high emissivity coatings are used on the steel plates to improve power handling. The cone is made from reinforced fibre pulp with a synthetic rubber roll surround.

Installed in the Bass Cube enclosure, the driver reproduces frequencies down to about 30Hz, tapering off below that.

In the lounge room it's a real window rattler. We also tested the Bass Cube in a car and while it's really too large for most vehicles, the results were pretty impressive.

By the way, the total cost of materials used to make your Bass Cube should be well under $300. Most of that is spent on the driver.

Design

When designing a subwoofer, there are numerous conflicting criteria to be taken into account. The first thing that needs to be considered is size.

A software program like BassBox makes it easy to come up with a subwoofer that will provide thunderous bass – if the enclosure is as big as a fridge, that is! Getting good bass response from a smaller enclosure is much more difficult and in fact, can

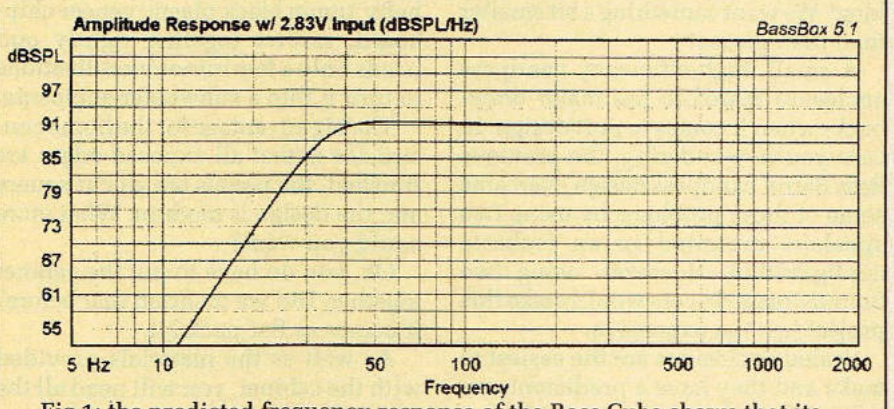


Fig.1: the predicted frequency response of the Bass Cube shows that its -3dB point is at 33.6Hz and that is has good efficiency.

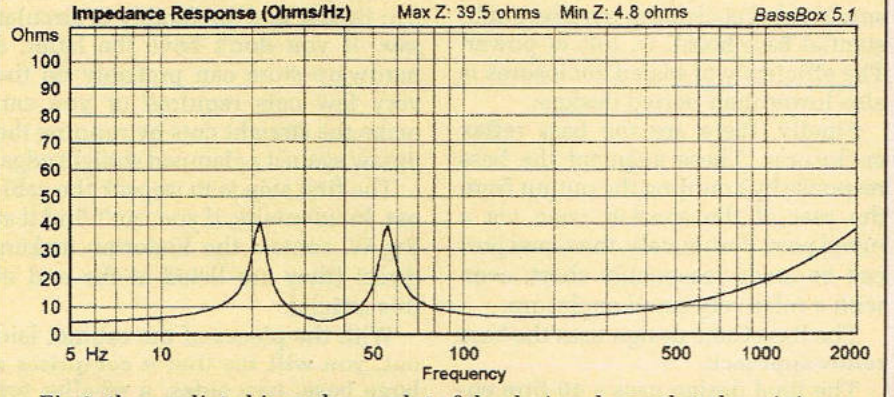


Fig.2: the predicted impedance plot of the design shows that the minimum impedance seen by the amplifier is 4.8Ω.

Loudspeaker Parameters

General Information

Company: Soundstream
Model: Rubicon 10

Mechanical Parameters

Fs	=	34 Hertz
Qms	=	11.5
Vas	=	45.4 litres
Cms	=	0.209mm/N
Mms	=	104 grams
Rms	=	1.947 kg/sec
Xmax	=	21mm
Sd	=	391 sq.cm
Dia	=	22.3cm

Electrical Parameters

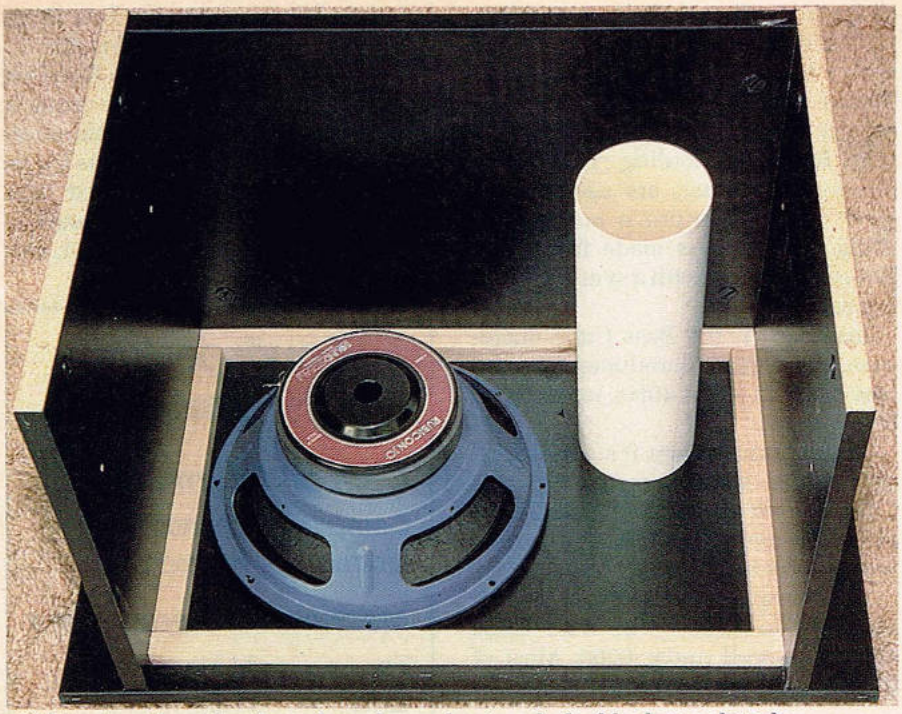
Qes	=	0.450
Re	=	3.6W
Le	=	2.9mH
Z	=	4W
BL	=	13.4 N/A
Pe	=	250W

Combination Parameters

Qts	=	0.430
no	=	0.341%
Sens	=	91dB (2.83V)

Vented Box Parameters

Vb	=	40.00 litres
Fb	=	34.6 Hertz
F3	=	33.6 Hertz
QL	=	7.0
Fill	=	normal
Ports	=	1 (round)
Dv	=	8.6cm
Lv	=	28cm



At this stage the side pieces have been shortened, the black woodwork assembled 'dry', and the bottom part of the internal frame loosely placed into position. Resting the speaker and the port into position will show you where you need to cut these holes in the baseplate.

be impossible with some drivers.

Fortunately, car subwoofers have boomed (pun intended) over the last five years, so there are now lots of high-power drivers available that are suited to compact enclosures.

The Soundstream driver specified here is rugged, comes with full specifications and is widely available from Strathfield Car Radio stores and other suppliers. At $199, it is also relatively cheap for a driver of this quality.

Having selected the driver, the next problem involved choosing a suitable enclosure. There are three commonly used enclosures: (1) sealed, (2) bass reflex (sometimes called ported) and (3) bandpass.

Bandpass enclosures allow very high efficiency (big acoustic power out for not much input) but they only cover a narrow frequency range; eg, from 30-90Hz, or less than two octaves. In this type of design, the driver radiates via two ports rather than directly from the enclosure.

Unfortunately, it requires very long tuning ports if we want good response at low frequencies. In fact, if the ports are made large enough in diameter so that "chuffing" noises don't occur, they may need to be metres long to correctly tune the enclosure!

The Bose Cannon is a classic example of this approach and it is 4 metres long! We want something a bit smaller than that, please!

A small, high-efficiency bandpass enclosure therefore has major drawbacks when it comes to port design. In case you're wondering, the previous Bass Barrel bandpass design overcame some of these problems by using two speakers mounted in an isobaric configuration. However, using two Soundstream drivers would make this project just too expensive.

Sealed enclosures are the easiest to make and they have a predictable response. However, the bass roll-off (gentle as it is) starts very early and so extended low frequency response from small sealed enclosures requires a substantial bass boost; ie, lots of power. The efficiency of sealed enclosures is also lower than ported designs.

Finally, there are the bass reflex enclosures. These augment the bass response by coupling the output from the rear of the speaker cone via a tuned port. Fortunately, the tuned port can be made reasonably short, even with a relatively small enclosure.

The Bass Cube design uses the bass reflex approach.

The final design uses a 40-litre enclosure. Its -3dB point is 33.6Hz and the minimum impedance seen by the amplifier is 4.8Ω.

Fig.1 shows the predicted frequency response, while Fig.2 plots the impedance curve. Before its response starts to taper off, the subwoofer should produce a sound pressure level (SPL) of 91dB at 1W (at 1 metre with a 2.83V input). That is a relatively high efficiency as far as subwoofers go. It is suitable for use with amplifiers rated from 50 to 250 watts.

Modifying the TV cabinet

Now that we had the basic design, we started looking at suitable enclosures. To make construction as simple (and economical) as possible, we wanted a commercial enclosure that could be modified to suit.

We found nothing really suitable until we started looking "outside the box". If there was nothing available designed for the purpose, what about something designed for another purpose?

That's when we spotted a Video/TV cabinet in the local Big W store. Eureka!

This cabinet is very suitable for this application. It is made from relatively hefty 16mm black plastic veneer chipboard, screws together tightly and needs only a few minor modifications to turn it into a subwoofer enclosure.

The big advantage for the home constructor is that all exposed edges are finished, the panels are all cut square and the design is modern. What more could you want?

Oh, you do have to put the cabinet together. Did we mention that before? It comes as flat-pack kit.

As well as the materials provided with the cabinet, you will need all the materials listed in the accompanying panel.

You will also need a drill, an electric jigsaw and preferably a circular saw. If you don't have the latter, a hardware store can probably do the very few cuts required or you can make the straight cuts by running the jigsaw against a clamped straight edge.

The first step is to unpack the cabinet. Incidentally, if you can't find it at Big W, contact the Victorian makers direct (they are listed at the end of this article).

With the pieces of the cabinet laid out, you will see that it comprises a large base, two sides, a smaller top and a shelf.

Fig.3, reproduced from the manu-

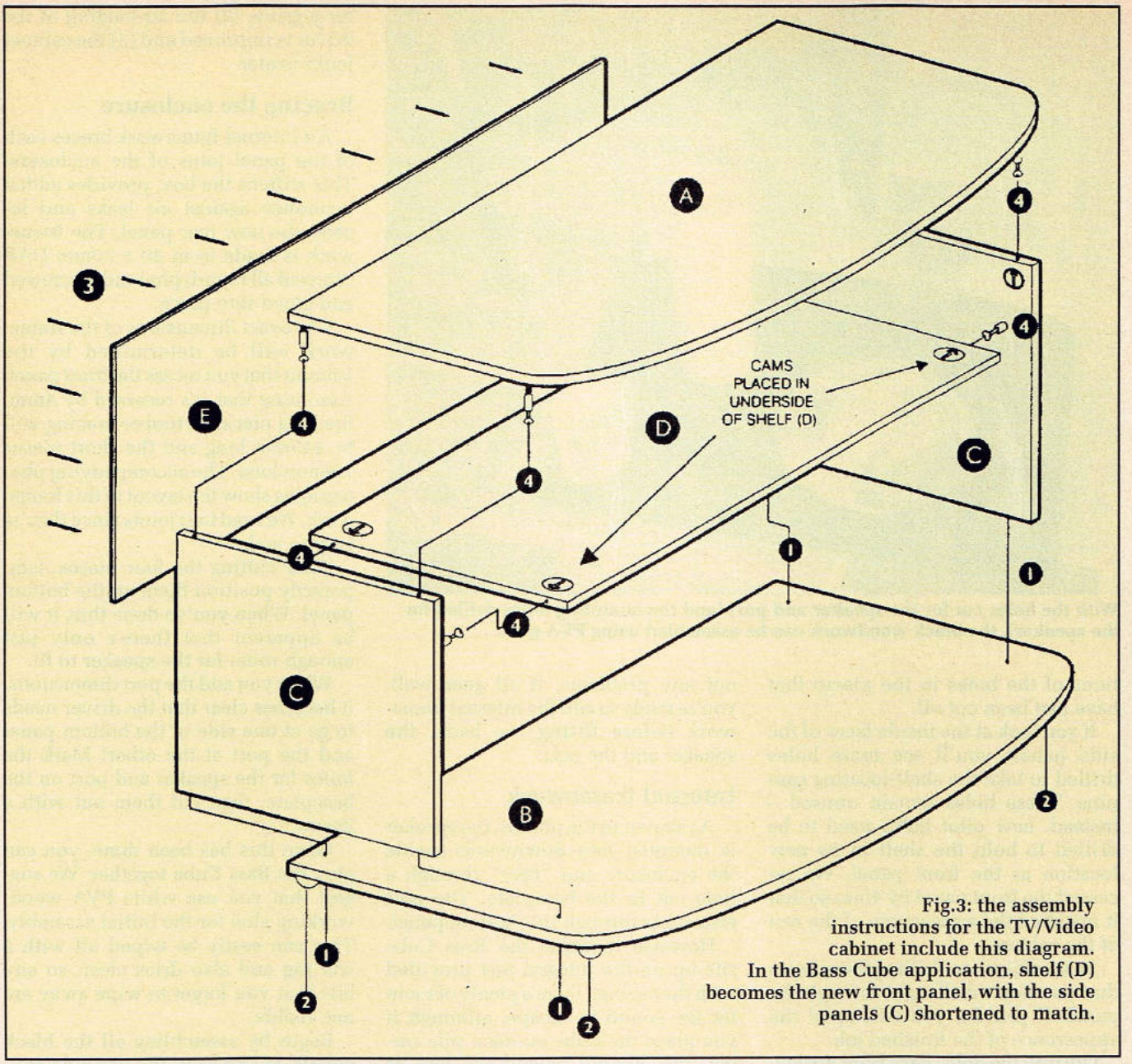


Fig.3: the assembly instructions for the TV/Video cabinet include this diagram. In the Bass Cube application, shelf (D) becomes the new front panel, with the side panels (C) shortened to match.

facturer's assembly instructions, shows the general layout.

In the Bass Cube configuration, shelf (D) becomes the front panel, while the side panels (C) are reduced in height to suit.

It's a good idea to first loosely assemble the cabinet (ie, don't fully tighten up the screws), so you can be sure how it all goes together. The action of the "cam lock" fasteners, for example, may not be clear until you do this.

Cutting the panels

The two side panels (C) should be cut to 337mm (high) by trimming their bottom edges. You will need to take special care to avoid chipping the black plastic veneer along the cutting edge. There are several things you can do to minimise this problem.

First, use a sharp, fine-toothed saw. We're assuming that you'll be using a circular saw, by the way, and that you will probably use it in conjunction with a straight edge guide to ensure a nice straight cut. Of course, there is nothing to stop you from using a hand saw.

Second, use a sharp Stanley knife to deeply score along both sides of the cut; ie, the width of the saw blade. In this way, the plastic is cut before the saw blade touches the material.

Also note that the blade will always tend to chip the material more on the underside of the cut. So it is a good idea to make sure that the underside is the side that won't be seen when the unit is ultimately assembled. On the other hand, you need to take care that the baseplate of the saw does not mar the material as it slides along.

If the saw does happen to leave minor blemishes in the plastic veneer, fill these with black paint.

Once you have shortened the side panels, redrill the pilot holes in the base of each piece. You can see where these need to go by checking the loca-

With the holes cut for the speaker and port (and the mounting holes drilled for the speaker), the black woodwork can be assembled using PVA glue.

tions of the holes in the pieces that have just been cut off.

If you look at the inside faces of the side panels you'll see more holes drilled to take the shelf-locating cam pins. These holes remain unused – instead, new pilot holes need to be drilled to hold the shelf in its new location as the front panel. We recessed the front panel by 4mm so that it matched the appearance of the rest of the cabinet.

Be careful when drilling these holes that you don't drill right through the panel. If you do, you will spoil the appearance of the finished job.

Once all the holes have been drilled, you're ready for a trial assembly. Don't use glue or screw anything fully home at this stage – just make sure that it all goes together in Bass Cube form without any problems. If all goes well, you're ready to add the internal framework before fitting the back, the speaker and the port.

Internal framework

As shown in the photos, the speaker is mounted face downwards inside the enclosure and "fires" through a hole cut in the baseplate. The port also vents through this bottom panel.

However, because the Bass Cube sits up on the integral feet provided with the cabinet, there's plenty of room for the sound to escape, although if you place the Cube on deep pile carpet, you should extend the feet or possibly fit furniture casters.

Taking the bottom-firing approach has a number of advantages: (1) the driver is protected without the need for a grille, (2) the air-loading of the driver is improved and (3) the cabinet looks neater.

Bracing the enclosure

An internal framework braces each of the panel joins of the enclosure. This stiffens the box, provides added insurance against air leaks and locates the new rear panel. The framework is made from 20 x 20mm DAR (dressed all round) pine and is screwed and glued into place.

The exact dimensions of the framework will be determined by the amount that you recess the front panel. Assuming that it's recessed by 4mm, the long pieces of timber bracing will be 445mm long and the short pieces 296mm long. The accompanying photographs show the layout of this framework. We used butt joints since they're easy to make.

After cutting the four pieces, temporarily position them on the bottom panel. When you've done this, it will be apparent that there's only just enough room for the speaker to fit.

When you add the port dimensions, it becomes clear that the driver needs to go at one side of the bottom panel and the port at the other! Mark the holes for the speaker and port on the baseplate, then cut them out with a jigsaw.

Once this has been done, you can glue the Bass Cube together. We suggest that you use white PVA woodworking glue for the initial assembly. This can easily be wiped off with a wet rag and also dries clear, so any bits that you forget to wipe away are not visible.

Begin by assembling all the black panels, ie; the base, the two side panels, the top and the front panel. The front and side panels are also secured to the base using screws.

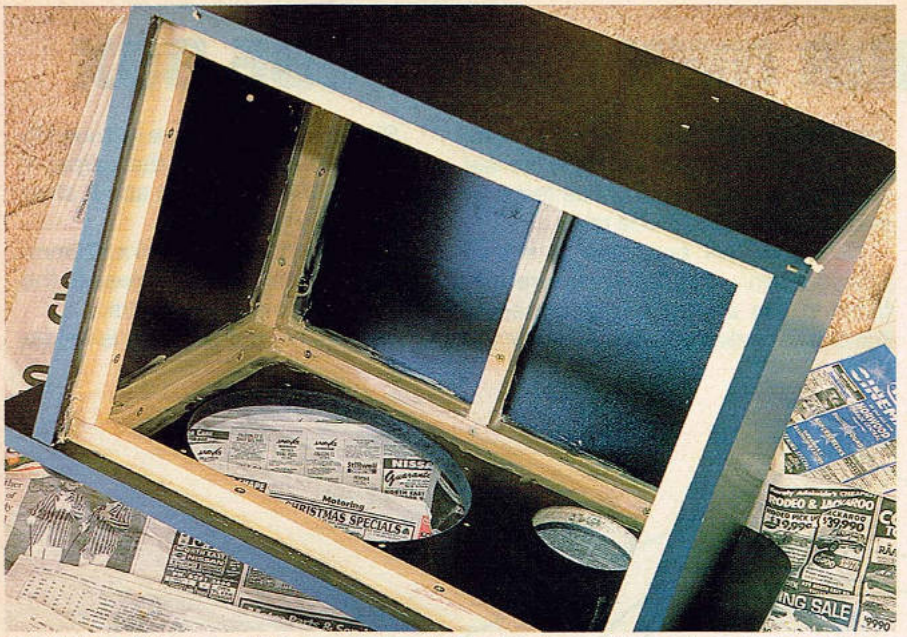
Let the PVA glue dry for a few hours before installing the internal pine framework. This should be glued into place using generous applications of Liquid Nails. Pick the water-soluble type of Liquid Nails so that it's easy to clean up and be sure to choose a well-ventilated area when applying the glue, to avoid inhaling the fumes.

In addition to the glue, we used two or three 6G x 30mm self-drilling plasterboard screws (inserted from each direction) to hold every piece of the framework firmly in position.

When inserting the screws, be sure

The Materials Required

- ❑ PVA glue and a tube of Liquid Nails (or a similar adhesive)
- ❑ One MDF panel about 443 x 335 x 18mm
- ❑ 5 metres of 20 x 20mm DAR pine, Meranti or similar timber
- ❑ 28cm of 90mm plastic stormwater pipe
- ❑ 50 6G x 30mm self-drilling plasterboard screws
- ❑ 12 6g x 35mm (or 40mm) self-drilling plasterboard screws
- ❑ 8 nuts, bolts and washers to suit the speaker mounting
- ❑ 1 speaker terminal and heavy-duty speaker wire
- ❑ 1 square metre of quilt wadding.



The internal framework is screwed and glued into position using chipboard or plasterboard screws and copious quantities of Liquid Nails. Note the use of a brace across the front panel (seen at back of picture). There is also another hidden piece across the underside of the top panel.

to drill pilot holes to avoid splitting the timber. We also stiffened the large front and top panels with additional lengths of 20 x 20mm pine, as shown in the photos.

When the glue dries you should have a stiff, well-sealed enclosure – apart from the open back, of course.

Mounting the speaker

The next step is to mount the 10-inch woofer and the port tube. The 28cm long port is cut from plastic stormwater pipe. It has a nominal outside diameter of 90mm and an internal diameter of 86mm.

To mount the driver, first mark and drill the eight mounting holes in the base. Be sure to use the gasket provided when installing the driver and tighten its mounting bolts down evenly so that the frame doesn't distort. The port tube can be glued into place using Liquid nails, making sure that there are no air leaks around its edge. The tube should be located so that its end is flush with the bottom surface of the base panel.

The rear panel is made from a 443 x 335mm piece of 18mm thick MDF (medium density fibreboard). Note that these were the dimensions used on the prototype; it would be wise to measure your own enclosure just in case it is slightly different.

The thicker rear panel does not require internal bracing. It should fit neatly into the enclosure and nestle against the internal framework, with its outer edge flush with the rear of the Cube.

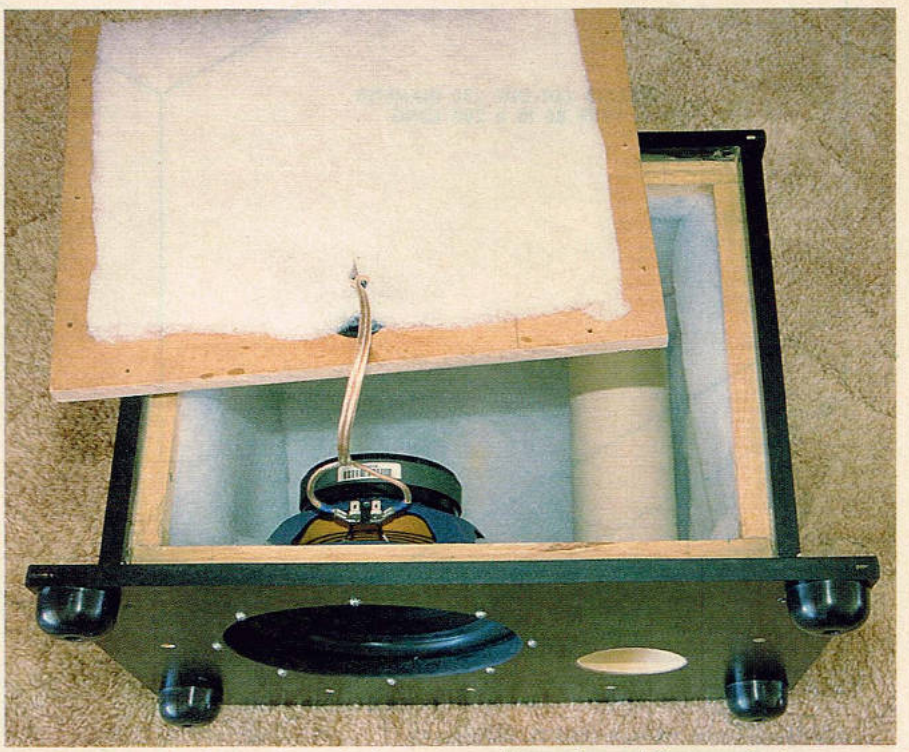
The back is held in place by 12 6G x 35mm screws but don't put them in just yet! First, you need to mount the rear terminal block (we used one from Dick Smith Electronics) and wire the speaker to it.

Soundstream state that the leads should not be soldered to the speaker (and may not honour a warranty claim if they are), so we used push-on spade terminals. Make sure that the positive and negative terminals on the driver are wired to the corresponding terminals on the rear panel terminal and use heavy-gauge speaker wire for this job.

Now cut some quilt wadding and glue it into place on the inside surfaces of the enclosure, not forgetting the inside of the back panel.

Make sure that the wadding doesn't block the port though, because that would seriously upset the performance of the Bass Cube.

At this stage, it's a good idea to connect the subwoofer to an amplifier and play some music, just to make sure that the driver and your wiring are OK. Keep the level reasonably low for this test though, as the unit is not yet sealed (the back isn't on). If everything seems fine, disconnect the amplifier and then glue and screw the back panel into place.



The final steps before sealing the box are to glue quilt wadding on the inner surfaces and wire up the terminal. Make sure that you use heavy-gauge cable for this purpose.

MAKING YOUR OWN BASS CUBE BOX

If you don't want to buy the TV/Video cabinet we modified for this article, there's nothing to stop you constructing your own Bass Cube in the conventional manner.

The diagram below shows how this can be done using 18mm MDF.

With this thickness of timber, internal bracing should not be required but all joins must be completely airtight.

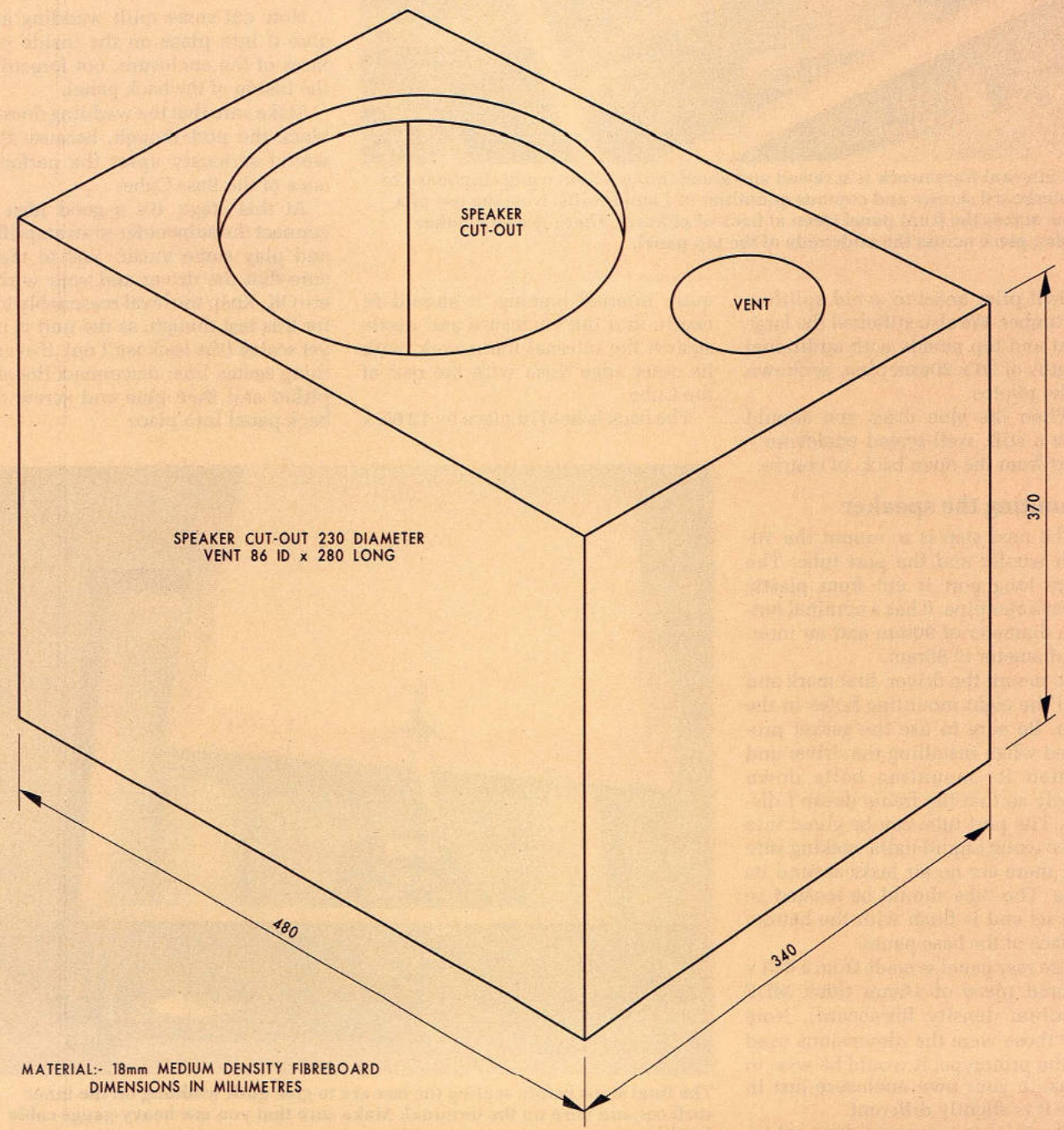
The speaker baffle should be the last panel fitted, following a similar test procedure as outlined in the text.

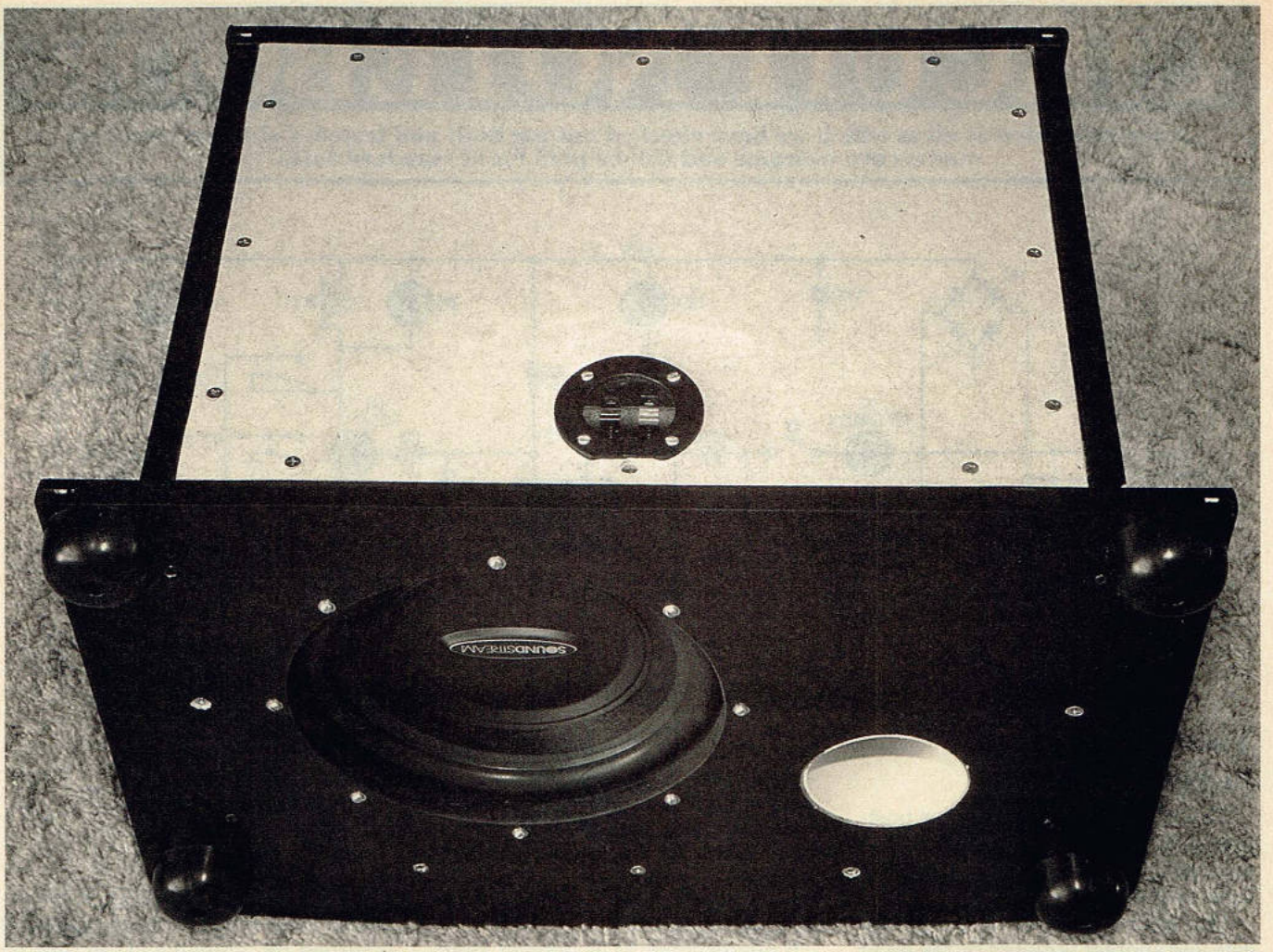
Note that this enclosure is shown upside down – like the enclosure featured in this article, it is designed to have the speaker and port aimed at the floor.

Similarly, the enclosure will need to be supported clear of the carpet – and note the comments about shag pile carpet in the text.

Incidentally, at 480 x 340 x 370mm, this subwoofer is getting close to the size seen in many large cars.

Yes, it's big but the bass is amazing!





The completed subwoofer lying on its front face. This photo gives a good idea of how all the pieces go together and the mounting positions for the speaker and port. Note the large 'feet' – this size lifts the speaker baffle off the floor enough for normal carpet but these would need to be even higher if the Bass Cube was sitting on thick, shag-pile carpet.

Again, be lavish with your use of Liquid Nails – you don't want any air leaks at all. Once you have done that, let the adhesive harden before launching into action.

Testing

The Bass Cube should be tested alone first, without other speakers playing. At this stage you want to be able to hear just what the Cube is doing – not have its sounds partially drowned out by the rest of the system.

Play some music relatively quietly through the sub and listen for buzzing noises – they can be evidence of air leaks. Moistening your fingers and moving them along all of the joins will also help you locate any leaks. These leaks must be sealed if the subwoofer is to perform well.

Perhaps the easiest way to seal leaks is by smearing some PVA glue into the join at the point where there is a leak and say 50mm each side, then wiping the excess off with a damp rag.

When the subwoofer is working without buzzes, turn up the volume – again with just the Bass Cube connected. Listen for distortion, clacking, buzzes, whistles and the like. If there aren't any, turn up the volume a little more.

If you have a powerful amplifier (or more frequently, a small amplifier that's driven into distortion!) you will clearly hear when the limits are reached.

Except for a very brief time during this testing, don't ever drive the Bass Cube into distortion. Note that this may occur without being noticed when the other speakers are connected and playing – you have been warned!

Like all speakers, the frequency response of the Bass Cube will be affected by its location within the room.

If it is placed against a wall or in a corner, its bass will be augmented – but will tend to be boomy or "muddy" as well. If your listening situation allows it, move the Cube around during testing until you find the most pleasing location.

Remember also that if you wade through the carpet at your place, you'll need to extend the Bass Cube's feet to lift the base panel above the shag pile.

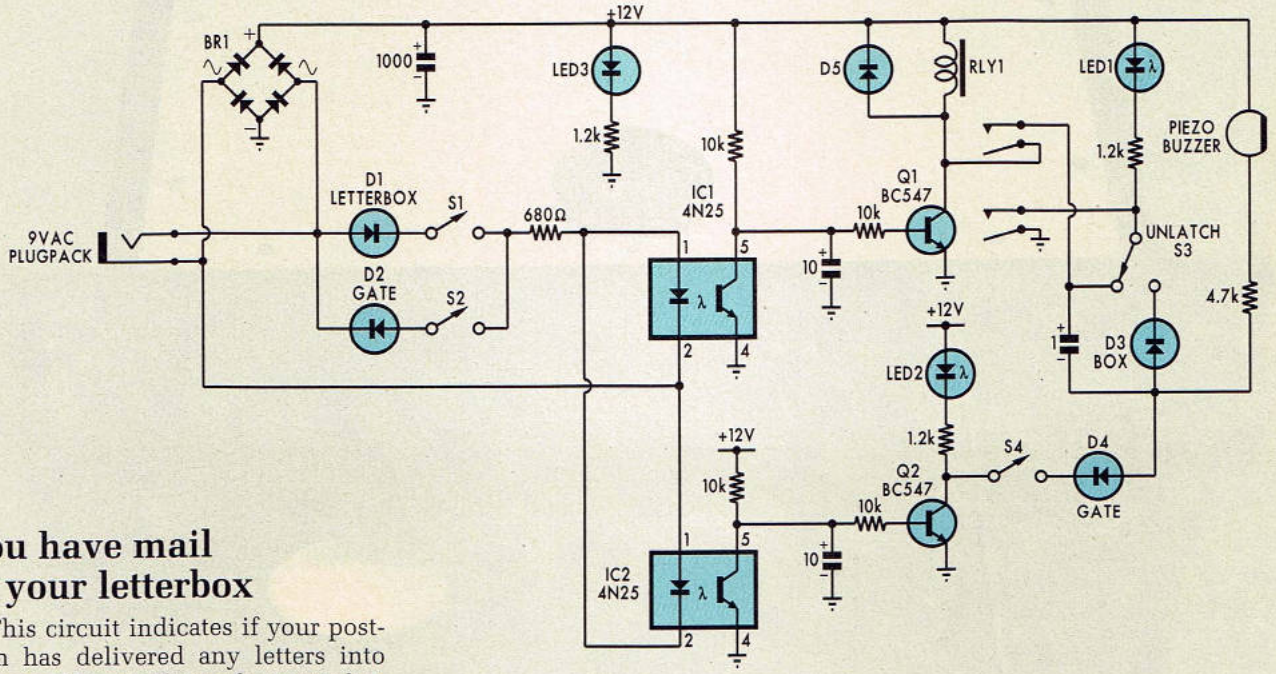
Given its size and cost, we were pretty pleased with the performance of the Bass Cube. We are sure that you will be too. **SC**

WHERE TO BUY THE CABINET

The Economy Video/TV Cabinet is available at any Big W store, or failing that is manufactured by:
Koala Furniture International Pty Ltd
(03) 9878 3688

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



You have mail in your letterbox

This circuit indicates if your postman has delivered any letters into your mail box or if your front gate has been opened.

One microswitch is closed by the gate and another is closed by the lid of the letter box. A 9VAC plugpack feeds a twisted pair which runs to the mail box and gate. Normally both microswitches are closed and current flows via diodes D1 & D2 to optocouplers IC1 & IC2 and these keep transistors Q1 & Q2 turned off.

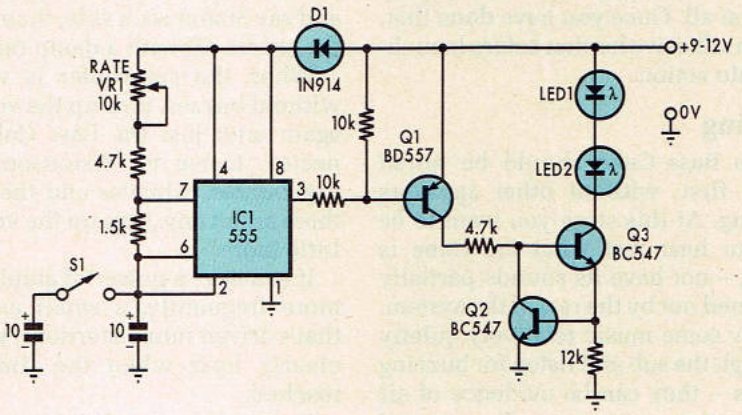
If microswitch S1 is opened, optocoupler IC1 is turned off and transistor Q1 turns on to drive relay RLY1. This relay can be made to latch with switch S3, in which case LED1 will stay lit even after microswitch S3 is allowed to close. Similarly, if microswitch S2 is opened, optocoupler IC2 is turned off, allowing Q2 to turn on and light LED2.

S4 allows Q2 to drive a piezo buzzer via diode D4.

M. King,
Masterton, NZ. ($30)

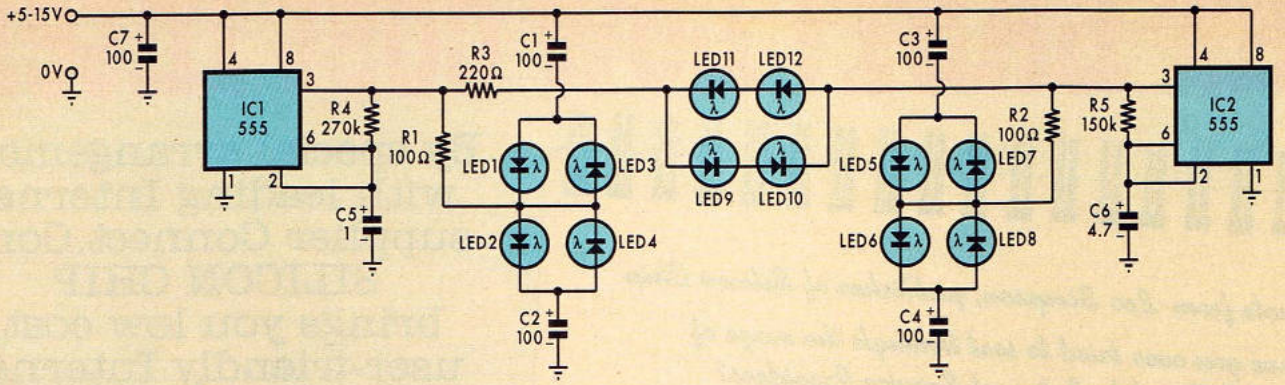
Relax your brain with just two LEDs

This circuit uses pulsed light from two LEDs to help and promote relaxation. The LEDs are mounted on an old pair of dark sunglasses, one for each eye, so that they are each pointing at the eye itself. The 555 timer is set to oscillate around 4-9Hz with switch S1 closed and around 8-18Hz with S1 open, depending on the setting of the 10kΩ pot, VR1.



Theta brain waves are generated between 3.5-7Hz and alpha brain waves between 7-14Hz. The circuit is safe to use, as the light output is very low. If it is still too bright, the light level may be reduced by increasing the 12kΩ resistor. The user should be sitting or lying down quietly, with the eyes closed and the mind at ease. Operation is via a 9V plugpack.

S. Williamson,
Hamilton, NZ. ($25)



Random LED flasher

This circuit uses two 555 timers to drive 12 LEDs. The LEDs can be arranged in a display so that they appear to blink or flash in a random fashion. It could be used as the basis for a Christmas light display.

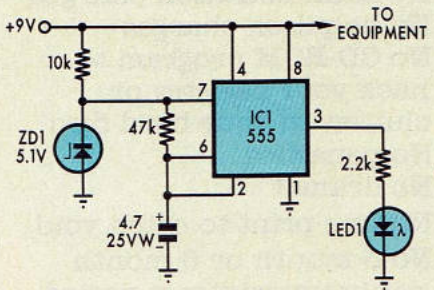
555 timers IC1 and IC2 are essentially identical oscillators, with different frequencies determined by R4 & R5 and capacitors C5 & C6. Both are a little unconventional in that the timing capacitor (C5 or C6) is charged and discharged from pin 3 rather than the usual arrangement of two resistors connected in series to the positive supply rail. The benefit of charging from pin 3 is that the duty cycle is close to 50% (ie, a square wave output).

IC1 drives four LEDs which are connected across the full supply. In a normal arrangement, LED1 would turn on when pin 3 was low and LED2 would turn on when pin 3 was high. In this arrangement though, the LEDs are fed via 100µF capacitors C1 and C2 and this causes the four LEDs to blink alternately as the capacitors are charged and discharged. LEDs 5-8 are driven in the same fashion by IC2. LEDs 9-12 are connected between the outputs of IC1 & IC2 to provide a further degree of randomness.

Resistors R1, R2 & R3 serve to limit the current into each string of LEDs.

Brian Critchley,
Elanora Heights, NSW. ($30)

9V battery monitor

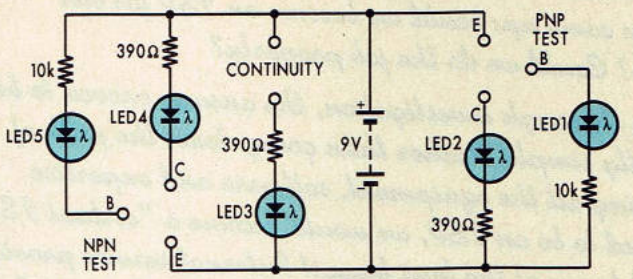


This circuit was designed to indicate the condition of a 9V battery in an electric guitar's preamp. LED1 is illuminated when the supply voltage is above a certain level and it flashes when the batteries need replacing. LED1 starts flashing when the supply falls below about +7.5V and it won't light at all below 2V.

The circuit consists is a conventional 555 timer driving LED1. The trick comprises the zener diode connected between pin 7 and 0V. In normal operation pin 7 oscillates between 0V and two-thirds of the supply rail voltage Vcc. If $^2/_3$Vcc is greater than the zener voltage, then the function of the 555 oscillator will be inhibited, since the zener will prevent the voltage at pins 2 & 6 from rising to the upper threshold voltage (ie, $^2/_3$Vcc).

To customise the circuit for your own requirements, decide on the minimum voltage that will operate the equipment correctly, and multiply by two thirds. This is the required zener voltage. As presented, the circuit draws 7mA @ 9V, falling to 5mA @ 7V. If lower current drain is desirable, use the CMOS version of the 555, the 7555.

John Kreckler,
St. Marys, NSW. ($30)



Simple tester checks transistors & continuity

This simple circuit will do a go/no-go test for NPN and PNP transistors. You need separate 3-pin sockets for NPN and PNP transistors. Plugging a transistor correctly into one of the sockets will show if it has gain, by turning on LED2 (PNP) or LED4 (NPN) although it will not distinguish between a transistor that has gain and one that has a collector-emitter short. To test for that possibility, plug the collector and emitter of the transistor into the Continuity socket. If LED3 lights, the transistor is shorted.

The Continuity tester socket can also be used to check LEDs, diodes and low resistance components.

Brenton Dick, Sisters Beach, Tas. ($20)

AT LAST! Low cost Intern

A note from Leo Simpson, publisher of Silicon Chip

Have you ever tried to sort through the maze of "deals" offered by Internet Service Providers?

I have! Some of them look really attractive until you start to read the fine print. Limits on this. Surcharges for that. Mysterious items on your bill. Cheap rates as long as you transfer your phone business ...

Suddenly they don't look so good!

As most readers will be aware, last year we set up the Silicon Chip website and while it is still evolving and will have more info placed on it, it is proving very popular. As a consequence of that exercise, we have inevitably been exposed to the Internet service provider (ISP) side of the business and we have had a good look at it and the question came up: could we become an ISP for our readers? Could we do the job properly?

After a thorough investigation, the answer proved to be elegantly simple. Rather than going down the path of acquiring all the equipment, software and expertise required to be an ISP, we would become a "virtual ISP", linked to one of the four biggest Internet service provider companies in Australia. That company is Connect.Com which is now a wholly owned subsidiary of AAPT.

If you don't have Internet access yet, we'll help you get it. And even if you're already with an ISP, check out what the Silicon Chip Internet access offer can do for you.

By special arrangement with leading Internet supplier Connect.Com, SILICON CHIP brings you low cost, user-friendly Internet access without the usual negatives of other Internet access plans.

Here's what you don't get:

- ✘ No time limits
- ✘ No 15 minute block charges
- ✘ No megabyte limits
- ✘ No download charges
- ✘ No excess megabyte charges
- ✘ No administration charges
- ✘ No helpdesk charges
- ✘ No CD-ROM program to hack your registry or clutter up your hard disc
- ✘ No penalties
- ✘ No drama!
- ✘ No fine print to catch you!
- ✘ No 3 month or 6 month minimum contract period.
- ✘ No setup charge if you stay with us for a minimum of 3 months

And there's a plan to suit YOUR Internet access requirements:

Low Volume User

Use this rate if you are a light user or a beginner. This is a great account if you just want to send and receive email and only use the worldwide web occasionally.

$10 per month gets you 5 hours then $2.50/hour

NO DOWNLOAD CHARGES

Regular User

Use this rate if you want to get onto the Internet for just a few hours per month and send/receive email.

$20 per month gets you ten hours then $2.20/hour

NO DOWNLOAD CHARGES

Power User

Use this rate if you want to download lots of data (music, software, pdfs etc) and you don't want to be hit with any excess megabyte charges. And NO RISK of being automatically disconnected when you're halfway through.

$49.95 per month gets you 25 hours then $1.95/hour

NO DOWNLOAD CHARGES

et access with no catches

Here's what you do get:

- ✔ Naturally you get your own email address - yourname@silchip.com.au - accessible from anywhere in the world!
- ✔ An easy to follow setup procedure using software already built in to your computer (Windows 95/Windows 98). No need to load new discs or CD ROMS.
- ✔ Fast access via 56K modems. Of course, if you have a slower modem, our system will allow you to access it at your fastest possible speed.,
- ✔ Currently, more than 32 in-dial locations (POPs) meaning your access is a local call. These locations will increase to more than 100 over the next year.
- ✔ Travel around a bit? Our system allows free roaming: you can use your account from any of our in-dial locations. While you might live in Melbourne, you can dial in from Sydney or the Gold Coast, for example. And there is no additional charge for this facility!
- ✔ On-line help and free help desk; you get a real live human to talk to if you have difficulties with setup or access and it's free.

Does all this sound good? Yes? Well, it gets even better.

- ✔ You get up to 3MB for your own web page.
- ✔ There are no cheques to worry about to pay your bill. We will bill you automatically every month by email and then we will debit your credit card automatically.
- ✔ If you want to cancel the service at any time, just email us and we will only charge you for that month plus your time charges to that date, if any.
- ✔ There are no cancellation fees, no administration fees or other charges (no setup fee if you stay with us for three months or more, otherwise a once-only $10 setup fee is payable).

The fine print

We told you there isn't any!

How do you get online?

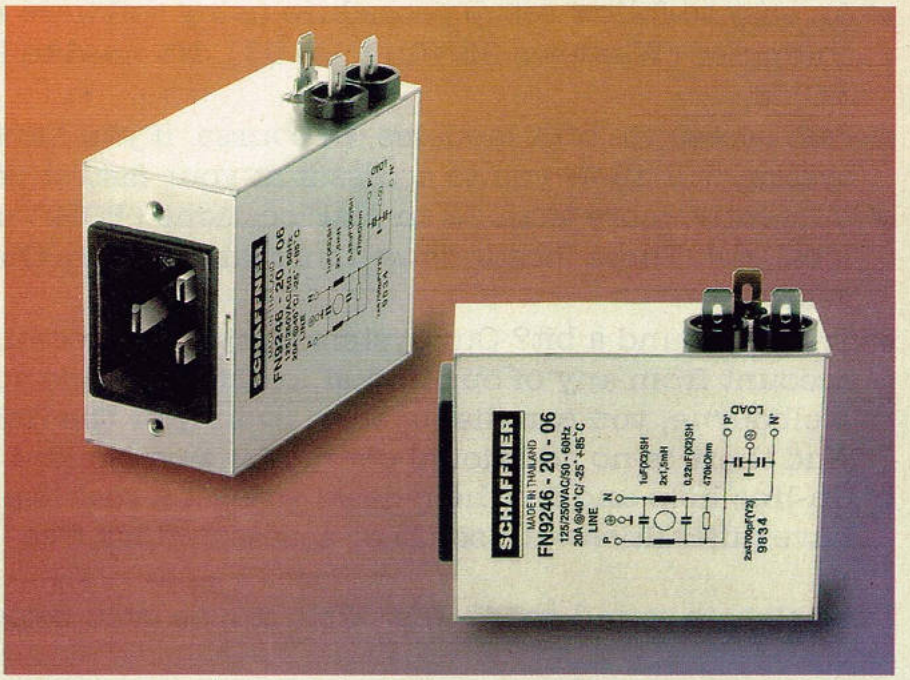
With credit card in hand, pick up the phone, dial (02) 9979 5644 and ask for Ann Jenkinson. It's that simple!

Still not convinced?

Check us out at www.silchip.com.au for more information.

PRODUCT SHOWCASE

Panel mounting inlet filters from Schaffner



These new Schaffner FN 9246 inlet filters provide EMI suppression characteristics typical of chassis-mounting filters but offer the convenience of direct panel mounting. The filters also feature fast-on connectors, leaving the rear face free from protrusions.

Schaffner FN 9246 filters are suited for the latest generation switchmode supplies such as those used in GSM base stations and small and medium-sized uninterruptible power supplies. The filters are IEC 950-compliant, rated at 250VAC and are suitable for mains frequencies to 400Hz. "B" versions are available with reduced leakage currents for medical applications.

FN 9246 filters are available in line current ranges from 1A to 20A and are compact, with a footprint of 30mm x 47mm, except for the highest current ratings (35mm x 75mm for the 16A and 20A versions). In comparison to other filters, the FN 9246 series have very high inductance and capacitor values so as to provide high attenuation of differential and common-mode noise.

Suppression characteristics typically provide 40dB of asymmetric attenuation at 100kHz, rising to 50dB from 200kHz to 30MHz.

For further information, contact Westek Industrial Products Pty Ltd, 2/6-10 Maria Street, Laverton North, Vic 3026. Phone (03) 9369 8802; fax (03) 9369 8006.

Clock radio has soothing sounds

A new clock radio from Dick Smith Electronics has "soothing sounds" built in. These "soothing sounds" are intended to relax the listener and send him/her off to sleep. There are four options to choose from: birds calling, waves breaking, rainforest and pond life. The user has the option of setting the sounds to run for 30, 60 or 90 minutes and the volume can be adjusted.

Apart from the soothing sounds, the Digitor set is a regular AM/FM clock radio with an alarm buzzer but it also has a large blue backlit LCD screen with a calendar that can be set to day/month or month/day format and a thermometer which displays temperature in Celsius or Fahrenheit.

The Digitor Natural Sounds Clock Radio is available from all Dick Smith Electronics stores at $79.50.

Toroidal power transformers from Harbuch

A range of toroidal power transformers specifically designed for the SILICON CHIP Class-A power amplifier (July & August 1998) has been released by Harbuch Electronics Pty Ltd. The range consists of type F2450, a 160VA, 2 x 21V model for the amplifier as published, type D2450, rated 80VA, 2 x 21V for building mono-block amplifiers, type PTT-4638, 160VA, 2 x 21V and a type PTT-4639, 160VA, 2 x 42V centre-tapped. The latter two models operate with reduced flux density, utilise tightly controlled winding geometry and are fitted with a flux band, all designed to reduce the leakage flux to an absolute minimum.

The model with the two separate centre-tapped windings is for those adventurous souls who would like to fit the transformer in the chassis with the amplifier modules (a power supply module is required for each channel).

Also available is the toroidal power transformer for the 500W power amplifier published in the August to October 1997 issues. Identical to the transformer used in the prototype, the PTT-4534 800VA model is also available to order fitted with a flux band. The tax paid price for the standard model is $134.50 direct from the manufacturer. Freight costs are additional and vary due to the weight of the transformer.

For further information, contact Harbuch Electronics Pty Ltd, 9/40 Leighton Place, Hornsby, NSW 2077. Phone (02) 9476 5854; fax (02) 9476 3231.

Wide range of services from Premier Batteries

Over the years, Premier Batteries have worked towards providing a one-stop shop for all rechargeable battery needs. They operate a refurbishment and diagnostic facility for hard-to-get batteries and for batteries that are out of production.

They can provide custom batteries, including special highly robust packs for the mining industry where extreme temperature and vibration tolerance are required. And they also manufacture a wide range of batteries for notebook computers, including IBM, NEC and Compaq.

For 2-way radio applications, Premier Batteries has introduced a range of low-cost, high-performance desk or bench top charger units. Developed using the delta-V principle and with microprocessor control, the units are designed to prevent overcharging and automatically switch to trickle mode at the end of charge, ensuring a long service life for the battery.

Interchangeable adaptors designed specifically for the following units are available: Icom BP157, 160, 174, 173 & 180; Kenwood KNB9, 12, 15 & 17 and Motorola GP300. These desktop chargers offer a safe and reliable charge for batteries in 1½-hours, for both nickel cadmium and nickel metal hydride packs.

For further information, contact Premier Batteries Pty Ltd, 9/15 Childs Road, Chipping Norton, NSW 2170. Phone (02) 9755 1845; fax (02) 9755 1354.

Australia's Dedicated Electronics Exhibition

NEPCON AUSTRALIA 99

25 – 27 May 1999
Melbourne Exhibition & Convention Centre, Melbourne

AROUND THE WORLD AND NOW IN AUSTRALIA

Invitation to join us at Nepcon'99

At Nepcon'99 you will see local and international electronics companies on show, discover the latest products, equipment and services, keep up with industry trends, attend a seminar, meet and mingle with industry's experts or catch up with colleagues. Nepcon '99 also introduces 3 Unique Educational Forums:

- **The INAC Line** – a working showcase of factory production lines. This "live" electronics manufacturing event allows you to see the true dynamics of working electronics assembly.
- **SEP** – the semi-conductor education pavilion for 'hands on' education in EDA tools, silicon, design in logic and micro-controller technology and specialised skills in manufacturing activities.
- **New Technology Showcase** for EMC/RFI products.

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9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

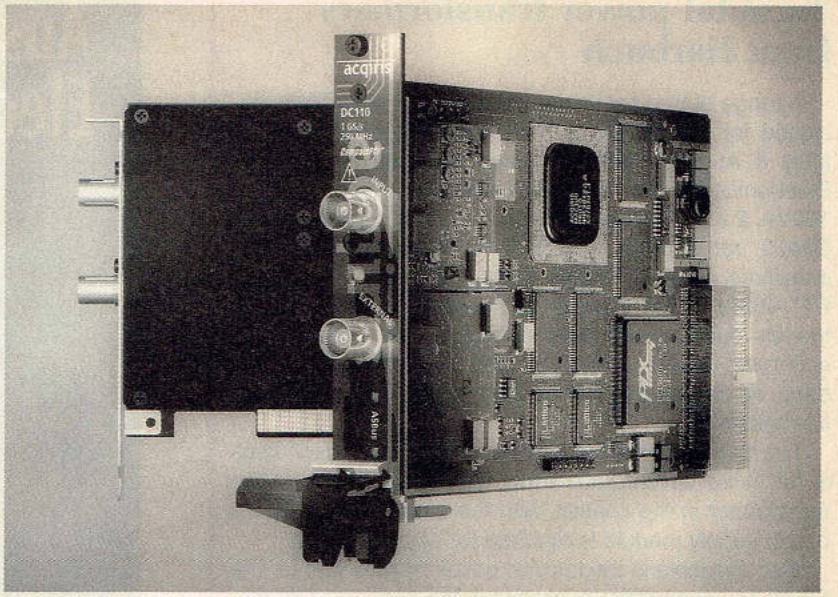
Wind-up torch lasts up to two hours

You've heard of the wind-up radio. Now there is a wind-up torch for those who can't stand the possibility of being torchless at the most critical moment. Called the "Freeplay", it will also appeal to those who are concerned about the quantities of batteries, both one-time use and rechargeable, which are being dumped in land-fills.

The user rotates the handle for about 30 seconds and this lights up the torch for about three minutes. Winding up the spring stores the energy which is then converted to electricity by a gear-driven generator in the torch. The unit can be stored in the wound-up condition so that it is always ready for use. It also has a built-in rechargeable battery which may be charged using a 12V AC or DC adaptor or a 12V car charger (not supplied). The battery gives a running time of about two hours. The torch uses a high efficiency Xenon bulb and a spare is included.

The torch can also be used to power other items which can run from 3V DC. There is also a flashing mode, for emergencies. The torch is made of durable yellow ABS plastic and is weather resistant. It comes with a 5-year warranty.

The Freeplay is available from all Dick Smith Electronics stores and is priced at $149.00. **SC**



World's fastest PCI/ PXI digitisers

Acqiris has released a new range of high-speed waveform digitiser products for use in computer-based data acquisition systems. The new digitisers include the models DP105, DP110 and DC110. The DP series are PCI-compliant and plug directly into a PC bus to turn the computer into a high performance digital oscilloscope. The DC110 is a compact PCI/PXI module for use in modular data acquisition systems.

Top of the line performance is achieved with the DC110 and DP110 cards. They feature high-speed (1GS/s) digitisers with wide bandwidth (250MHz) front-ends and long acquisition memories (up to 2Mpoints). The DP105 is a low-cost alternative with 500MS/s sampling, 150MHz bandwidth and up to 1Mpoint of memory. The digitisers all deliver oscilloscope-like performance with input voltage ranges from 50mV to 5V full scale, 50Ω and 1MΩ coupling, variable offset, full input protection and flexible triggering.

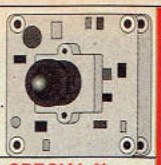
A sequential trigger mode that rearms with less than 500ns of dead time is standard and makes the capture of high repetition rate, burst or impulse-response type signals easy. Waveforms can be recorded as they arrive, complete with trigger timing information.

Acqiris digitiser cards are supported by AcqirisLive, a digitiser control program for Windows 95/98/NT and they work with "off-the-shelf" software packages such as National Instruments' LabWindows/CVI and LabVIEW. The digitisers are fully programmable and are capable of transferring data to a PC at rates up to 100Mbytes/s over the PCI bus.

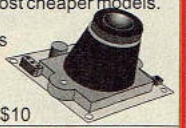
Typical applications include telecommunications, magnetic media testing, mass spectrometry, lasers, computing military, EMI/EMC, high voltage impulse testing, automotive, particle physics and chemistry.

For further information, contact Acquiris Pty Ltd, PO Box 317, Blackburn, Vic 3130. Phone (03) 9877 9322; fax (03) 9849 0861.

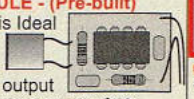
COLOUR CCD 42X42mm CAMERAS
with 1 of these lenses 3.6mm-92 deg./4.3mm -78 deg. 5.5mm60 deg. Special introductory Price of just $189



**** CCD CAMERA SPECIAL ** WITH A FREE UHF MODULATOR**
The best "value for money" CCD camera on the market! 0.1 lux, High IR response & hi-res. Better than most cheaper models.
32 X 32mm $99...
With 1of these lenses pinhole (60deg.), 78 deg.; 92 deg.; 120 deg.
or for (150 deg) add $10

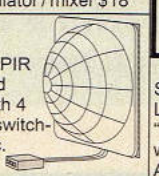


MINI AUDIO MODULE - (Pre-built)
This amp/pre-amp is Ideal for use with our cameras. 12Vdc, Hi sensitivity, 0.6W output operation includes electret mic. $10



4 CHANNEL VIDEO SWITCHER KIT
This kit can switch manually or sequentially up to 4 audio/video sources. Other features inc. VCR relay output to switch STOP/REC, can be switched with PIR or alarm system inputs Add a security channel to your TV using a UHF modulator, watch TV & flick channels & see who's at the door or what the Kids are doing. This unit can be switched automatically using the PIR units below. Kit +PCB+all on-bourd components inc. 18 relays. Less than Half price of most units $50. Optional VHF modulator / mixer $18

MINI PIR DETECTOR PCB MODULE (G66)
Pre-built 30mmX34mm PIR module with an attached Freznel lens & cable with 4 pin connector Ideal for switching cameras, alarms etc. bargain at just: $18



POWERFUL IR ILLUMINATORS
With strong universal swivel mount & 50X50X50mm housing:10 LED $10... 30 LED $20...80 LED $36

5" MONOCHROME MONITOR
Brand new pre-built12V@ 600MA. Ideal for security or swap 2 wires to make rearview monitor for trucks & busses. Black & amber picture pleasant to watch. Plus composite video conversion kit . Kit inc. PCB + all on-board components + monitor. Coming soon for around $30

VCR CONTROLLER KIT:
Ref: SC Sept 97. With our Trigger Kit, a ready made USED PIR Detector & Learning Remote Control you can trigger any domestic IR remote controlled VCR to record human activity within a 6m range with a 180deg. view. Starts VCR recording at the first movement & stops a few min. after the last movement. No connection needed to your existing VCR. This kit has Relay outputs, easy to interface with a VCR / Remote Control. PCB and all on board parts:$25. A suitable miniture used PIR Detector module:$16.

FREE*FREE***FREE**
Ask for a free tunable balanced mini VHF Astec brand Hi quality modulator with any camera order. Connection Diagram supplied

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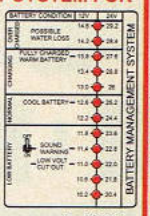
Post & Pack typically $6

CURRENT MODEL
YAMAHA LINEAR ROBOTIC ARMS AT 5% OF THEIR ORIGINAL COST
, X-RAY MACHINES, HEART MONITORS, SATELLITE TV, TEST EQUIPMENT
These are some of the items that may still be for sale at our Web Site. See our BARGAIN CORNER, TRADERS CORNER & FREE ADS
FREE ADS should be E-mailed with "FREE ADS" in the subject window

KITS OF THE MONTH

COMPLETE INTELLIGENT BATTERY / POWER MANAGEMENT SYSTEM FOR THE HOME OR CAR COMING SOON



New Battery Monitor Kit: 12v / 24v monitor with low voltage cut-out, audible alarm before cut-out. This monitor is designed to use minimal power & has a battery saving 12 led bar-graph indicator. Kit inc PCB, all onboard components, label, 10A cut-out MOSFET + suitable surplus case . All for the special introductory price of $32....For 50A MOSFET (IRFZ44) add $3.
SWITCHING REGULATOR KIT: Designed to work with the above system and turns on @13.4V / 26.8V and turn off @13.8V / 27.6V. Kit includes PCB + all on-board components ind. 1x50A MOSFET (space on PCB for to add more MOSFETS) Switching regulator + above monitor $49.

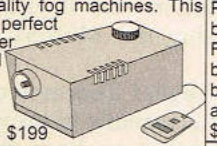
CLOCK WITH CALENDER AND TIMER
12V DC 12Hr. clock for automotive / domestic/ timer use, large (13mm) Green LED display, AM-PM indicator, Date, Month, 24Hr. Alarm, 59 Min. sleep timer, back up batt.. Xtal controlled 50Hz (20ms) clock can also be used for CRO calibration and inverters. Can switch external load during Alarm/timer, 0.5A load directly, or 10A with additional MOSFET, Alarm piezo speaker provided. PCB & all comp's kit: $14 Small Piezo speaker to suit $1extra. Suitable surplus box + swivel mounting/+12A mosfet: $4 Full data sheet for LSI IC used (MM5382): $0.80

HUGE WEB SITE SALE
FROM JUNE 4th. until JUNE 7th
MORE INFO ON OUR WEB PAGE

*******SPECIAL POCKET PAGERS*******
Small modern used pagers, brands inc. LINK, PHILIPS, RTC. condition "unknown", all have two small (grain of wheat) 1.5V lamps and lots of other parts. All are powered by one AA cell. 4 for $5

OPTO PACK A total of 104 opto devices: various colours & types. All top quality brands. Siemens etc.. All for just $10.
VISIBLE LEDs...5mm
14 X Yellow clear...6 X Red (clear) 24deg....2 X Yellow LED (clear) 24deg. 16 X Red LED (clear) 24deg...38 X Green LED (clear) 24deg.
3mm
14 X Red LED diffused 70deg.
4 X 3mm or rect. Yel. LED diffused 70deg
SPECIAL
1 X 5mm IR LED...3 X 3mm Clear Phototransistor...3 X 5mm Clear Phototransistor...1 X IR Receiver module 2 X DIL rect. black PIN Photodiode.

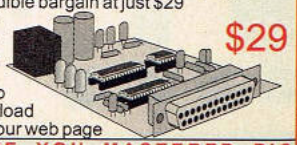
FOG MACHINES..... JUST ARRIVED
Professional quality fog machines. This unit would be the perfect partner to our laser light shows, Ideal for discos, parties, fashion parades etc.
A special price of $199



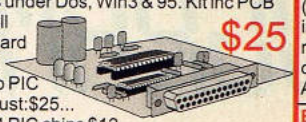
PELTIER EFFECT DEVICES
Make a solid state food cooler / warmer for the car etc. with 2 heatsinks, a fan and one of the following. Could be used for cooling overclocked PC CPUs. All 40 X 40mm.
4A △T 65deg. Qmax 42W $25
6A △T 65deg. Qmax 60W $27.50
8A △T 65deg. Qmax 75W $30
Device comes with instructions to build cooler / heater plus data. Some used surplus heatsinks avail.

N E W * N E W *** N E W *** N E W**
PELTIER CONTROLLER: This kit is a sw-mode design & correctly controls temp. of peltiers to 10A (very efficient design) PCB + onboard parts + new surplus case. $15

LEARN TO PROGRAM PIC. ICs.PIC MICRO PROGRAMER. Ref. SC-MAR-99
Design your own microprocessor controlled devices or even products and maybe make your fortune! Learn program your own 16F83 /16F84 /16C84 micro-controllers with this kit the simple way. with this small, cheap but powerful chips Kit inc. program examples and notes PCBs, all on-board components, Db25 connector and a PIC chip ready to program.An incredible bargain at just $29
Soft-ware avail-able free to download from our web page



HAVE YOU MASTERED PIC PROGRAMING?
THEN TRY OUR PROFESSIONAL . PIC MICRO PROGRAMER KIT.
Programs up to 39 Different 8, 18, 28, and 40 pin types of PIC chip. Quick Easy construction and uses serial programing method via your Pc's parallel port and uses BOJAN DOBAJ's software that works under Dos, Win3 & 95. Kit inc PCB plus all on-board parts but no PIC chip Just:$25... 16F84 PIC chips $12



CIGARETTE LIGHTER PLUG & LEAD
With LED indicator, Fuse and small internal PCB. Space for small projects like voltage regulators etc. 10 for $6

KEY-CHAIN LASER POINTER
Very bright 650Nm High quality machined metal housing

VERY BRIGHT LASER MODULE $18
650Nm laser module as used in the above pointer. (Lm2)

NSW new laws may apply soon $14

SHOP MINDER / IR FENCE
IR transmitter & receiver kits (two separate PCB's), basic range is up to 20M but can be greatly increased by adding a lens. Features include output to drive piezo buzzers or relays etc. Two PCB's + all on-board components: $17 Options: 2 suitable boxes + 2 swivel mounts: $6, Buzzer: $3, 12A relay: $3 (fits on PCB) Lens: $0.80

NEW SUPER LOW PRICE + LASER AUTOMATIC LASER LIGHT SHOW KIT: MKIII. Automatically changes every 5 - 60 secs, & is adjustable. Each motor has 8 speeds, one motor is reversible, & one can stop. Countless great displays from single to multiple flowers, collapsing circles, rotating single and multiple ellipses, stars, etc. Easy mirror alignment with "Allen Key". Kit inc. PCB, all on board components, three small DC motors, mirrors, precision adjustable mirror mounts: (K115) + very bright 650nM laser (LM2) module.

BEST VALUE $1
for our famous wiring kit with any order

DON'T BE FOOLED

This is not an April 1st joke!

BRAND NEW GERMAN MADE DUAL PRINTER / SCANNER MECHANISM
Made in 98, worth $1800!! Made for a govt. contract that failed. Use it "as is" or "Pull it apart" to recover:
SIX MINEBEA STEPPER MOTORS,
2x6 wire type 23LM-C355-38V 50x55mm,
3x6 wire type 17PM-H303-04V 37x 42mm,
1x4 wire type 17PM-M007-02, 42x33mm,
PCB WITH SGS STEPPER DRIVER ICS.

POWERFUL, COMPACT, SWITCH-MODE P.S. WITH FAN: 240V input, output: 1+5V/8a, -12v/ 1.5a, +12v/1a, +32v/4a.
NUMEROUS OTHER PARTS:
Include **24 PIN PRINT HEAD, OPTICAL SCANNER, CPU, EPROM, matching BELTS & PULLEYS,** two **GEARED MOTOR ASSY'S** with micro switches, **MAINS FILTER etc. etc.**

UNBELIEVABLE PRICE: $36
Printer ribbon to suit $5, extra. Delivery to most Aust. cities $12, . box approx. 0.25 CM - 15Kg
MORE INFO, LINKS AND PHOTOS IN BARGAIN CORNER ON OUR WEB SITE

NEW MOSFET VERSION OF OUR 1/2/3 AXIS CNC SYSTEM.
(computer numerical control) This system includes a new stepper motor driver kit (one kit required for each axis) designed to be used with software freely available on the Internet for use with home or professionally built a milling machine, lathe, engraver or cutter etc. with home & limit switches & a high degree of accuracy (can be better than .001". We supply the kit inc. Pcb all onboard parts etc. plus Internet resources shareware software & building or buying mechanical components. Around $40 per axis. Call for details.

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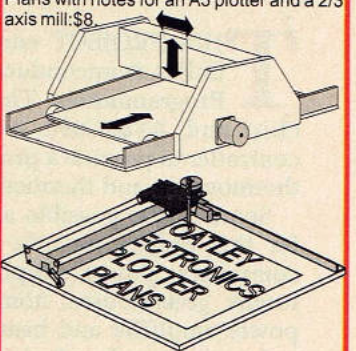

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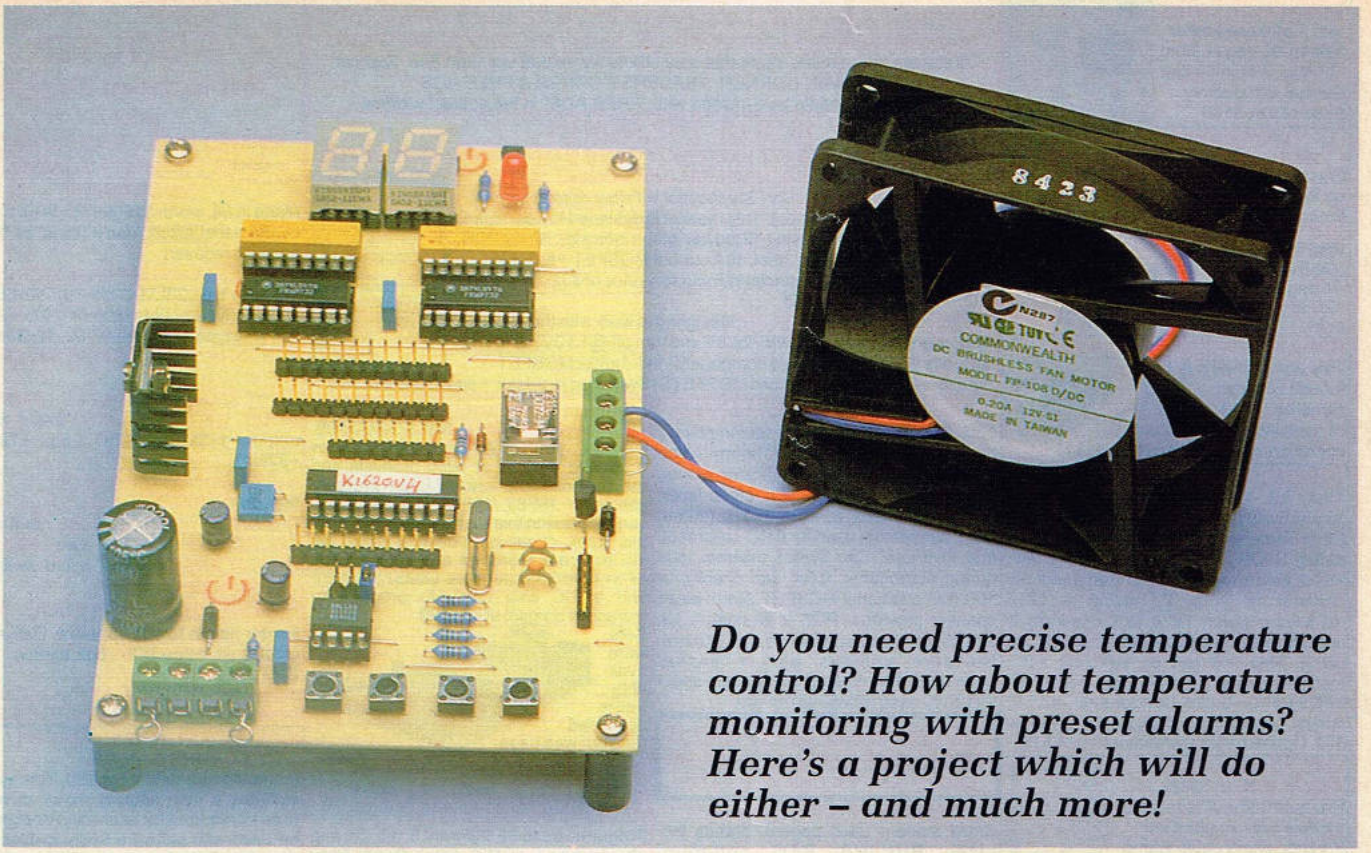


Do you need precise temperature control? How about temperature monitoring with preset alarms? Here's a project which will do either – and much more!

A PROGRAMMABLE thermostat/thermometer

By KEITH RIPPON

THIS PROJECT combines the Dallas Semiconductor DS1620 Programmable Thermometer chip and AT89C051 8-bit microcontroller to provide a programmable thermometer and thermostat.

Some of the possible applications for this project include incubators, computers, power supplies, drying rooms, greenhouses, home brewing, power amplifier and heatsink monitoring or any other devices requiring temperature monitoring or control.

The AT89C2051 microcontroller from Atmel is one of the smallest members of the 8051 family. As the saying goes, "Good things come in small packages". This one comes in a 20-pin package and features 2K bytes of programmable Flash memory, 128 bytes of RAM, 15 programmable I/O lines, two 16-bit timer/counters, six interrupt sources and an on-chip analog comparator.

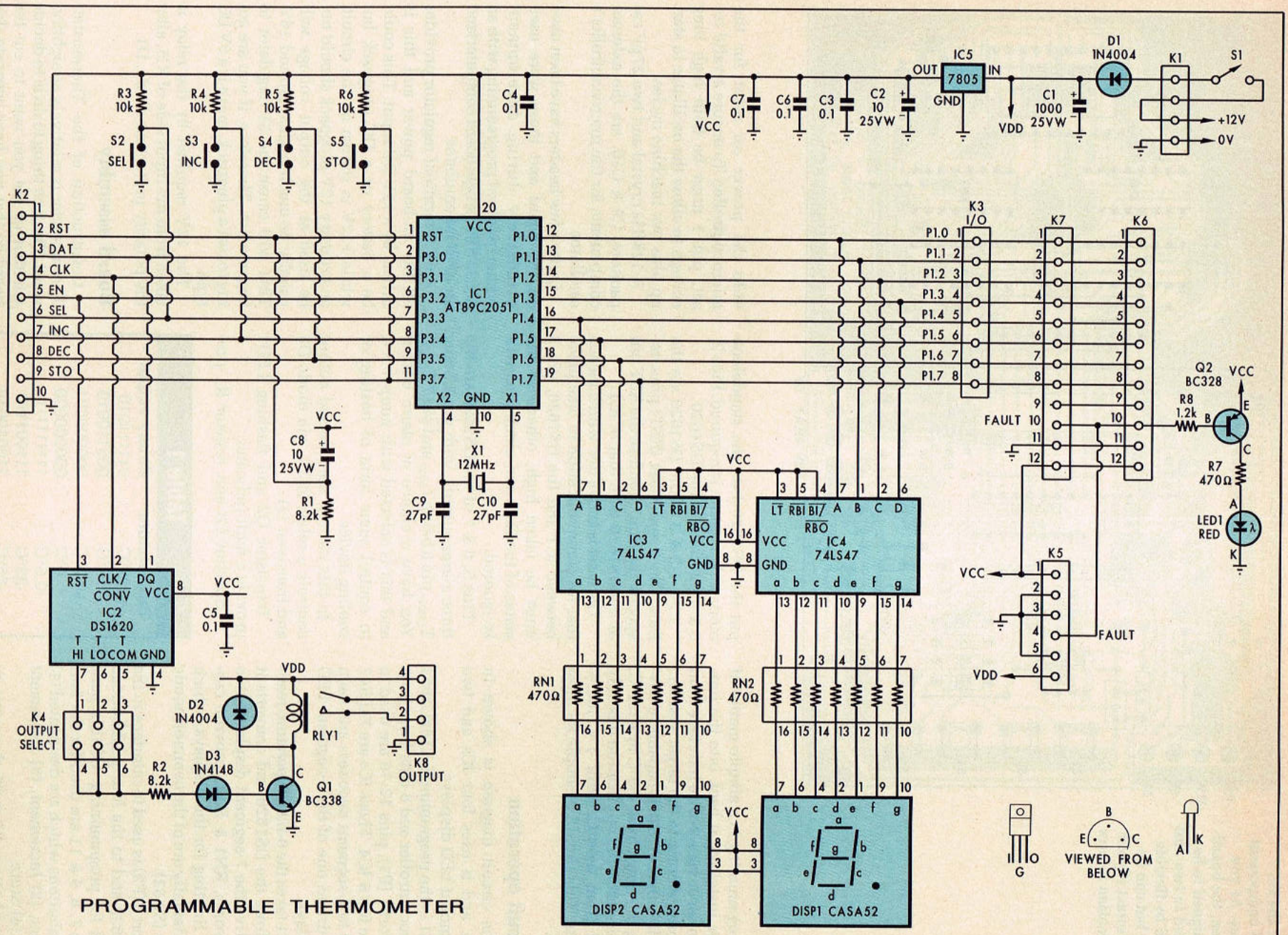
It is fully compatible with the MCS-51 architecture and it can be programmed using the MCS-51 instruction set.

The DS1620 Digital Thermometer and Thermostat is capable of providing 9-bit temperature readings from -55°C to +125°C in 0.5°C increments. It has three thermal alarm outputs, T_{com}, T_{low} and T_{high}, which allow the device to operate as a thermostat. T_{com} is driven high when the temperature exceeds T_H and remains high until the temperature falls below that of T_L.

T_{low} is driven high if the DS1620 is less than or equal to a user defined temperature T_L. T_{high} is driven high if the DS1620 temperature is greater than or equal to a user defined temperature T_H. The temperature reading is provided in a 9-bit, two's complement format.

Table 1 shows the binary output data at various temperatures. The temperature data is transmitted over a 3-wire serial interface, comprising Data, Clock and Rst, LSB first. The user-defined temperature settings are stored in non-volatile memory and this allows the device to be programmed prior to being installed in a system.

This makes for a relatively cheap and accurate thermostat, while allowing for an easy way to alter the end product's temperature parameters.



PROGRAMMABLE THERMOMETER

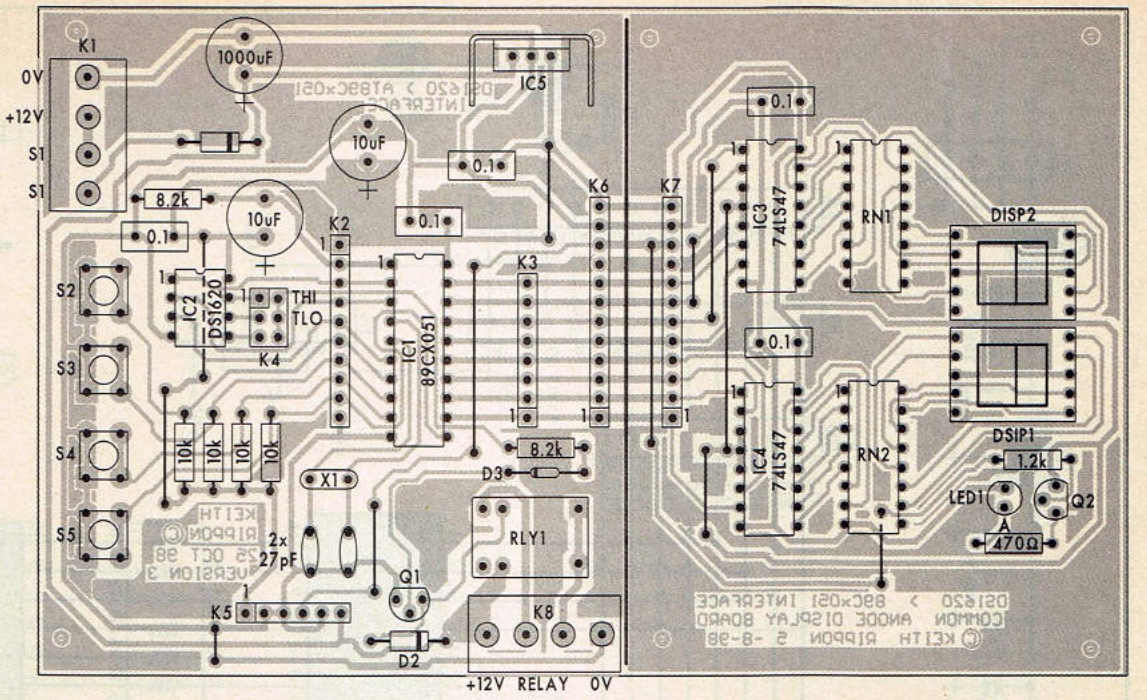


Fig. 2: the PC board component overlay. As you can see, the board is designed to be divided in two and joined by flexible cable but can be used intact if your application allows it.

Reprogramming is a simple matter of either installing it back into the programmer or via a 3-wire interface from the programmer to the target system.

While the DS1620 is capable of covering the range from -55°C to +125°C, in this particular application it is only used from 0-99°C, with 1°C increments. This should be ample for most uses.

Circuit operation

The circuit diagram is shown in Fig.1 and it uses four ICs and two 7-segment LED displays.

IC1 is the programmed AT89C2051 microcontroller and 8 data lines from its Port 1 (P1), pins 12-19 are used to drive IC3 & IC4. These ICs are 74LS47 BCD to 7-segment decoders and each one drives one of the 7-segment LED displays.

IC1 takes the 9-bit temperature reading from the DS1620 and converts it to drive the 7-segment displays. Two networks, RN1 & RN2, provide current limiting for the displays, which incidentally are of the common anode type (SA52).

Port 3 (P3) is used to interface to the DS1620 and to the four pushbuttons used for programming. Of this port, pins 7, 8, 9 & 11 are used for the four pushbuttons which are designated (1) Select, (2) Increment, (3) Decrement and (4) Store.

Pushbuttons S2 & S5 also serve to put the DS1620 into the standalone mode if this option is required. Pins 2, 3 & 6 interface to the DS1620.

Pins 1,2 & 3 of the DS1620 are the Data, Clock and Reset (RST) pins, respectively. Don't confuse the RST pin of the DS1620 with that of IC1.

The reset is active low which means that for communication to take place between IC1 and the DS1620, pin 3 must be taken high, otherwise the states of the Data and clock pins will be ignored.

Pins 5, 6 & 7 of the DS1620 are the three alarm outputs, with pin 5 being T_{com}, pin 6 being T_{low} and pin 7 T_{high}. You have a choice of alarm output and this is selected with jumper K4, to control some form of heating or cooling device

In this circuit, the selected output controls a relay, RLY1, via diode D3 and transistor Q1.

Transistor Q2 and flashing LED1 provide a fault indicator.

Capacitor C8 and resistor R1 provide the power on reset for the microcontroller. To ensure a valid reset, pin 1 must be held high long enough to allow the oscillator to start up plus two machine cycles.

A 12MHz crystal and two 27pF capacitors, C9 & C10, are the external components for the microcontroller's oscillator.

Quite a few headers have been used on the board and these were used extensively during development which involved programming with an 80c32 SBC (single board computer)and an EPROM emulator.

A 5V 3-terminal regulator provides all the on-board power and this is driven by a 12V DC input. This could be a battery or a DC plugpack but while +12V is shown on the circuit, an ordinary 12V plugpack should not be used as the output voltage will usually be much higher, around 16V. That will cause the 5V regulator to become hot. Therefore, if you are going to use a plugpack, make it a 9V DC type.

The 12V required by the relay is taken from the input side of IC5, after the polarity protection diode, D1.

Table 1

Temperature	Binary output
+125°C	011111010
+25°C	000110010
+0.5°C	000000001
0°C	000000000
-0.5°C	111111111
-25°C	111001110
-55°C	110010010

Board assembly

Construction of the Thermostat/Thermometer is relatively straightforward. The first thing to do is to decide whether or not you want to cut the board so that you have separate dis-

play and microcontroller boards. It is much harder to cut the board once it is populated so you have to make the choice before assembly starts.

If you do decide to have two separate boards, you can mount them at rightangles to each other or join them with a length of ribbon cable. Note that headers K6 and K7 make provision for the ribbon cable link.

The next thing to do is to check the copper side of the board for shorted or open circuited tracks. These could lead to problems when you come to powering up the board, not to mention that it could be expensive if you happen to "blow up" some component, especially the DS1620 or AT89C2051.

Here's a tip before you start: if you find that the components are falling out of the board when you flip it over to solder them in, a piece of masking tape makes a good substitute for a third hand.

You can start the board assembly with the installation of the wire links. They are easier to solder in if the wire you use is not tarnished, so use bright and shiny tinned copper wire or freshly cut off component pigtails.

Next you can insert and solder in the resistors, diodes, LED, transistors (check the orientation), capacitors and pushbuttons. After this you can install the IC and display sockets but don't insert the ICs or displays yet.

I suggest using the machined pin sockets. While they are more expensive they are more reliable. If you can't afford them at least use one for the DS1620. The cheaper standard sockets do not lend themselves well

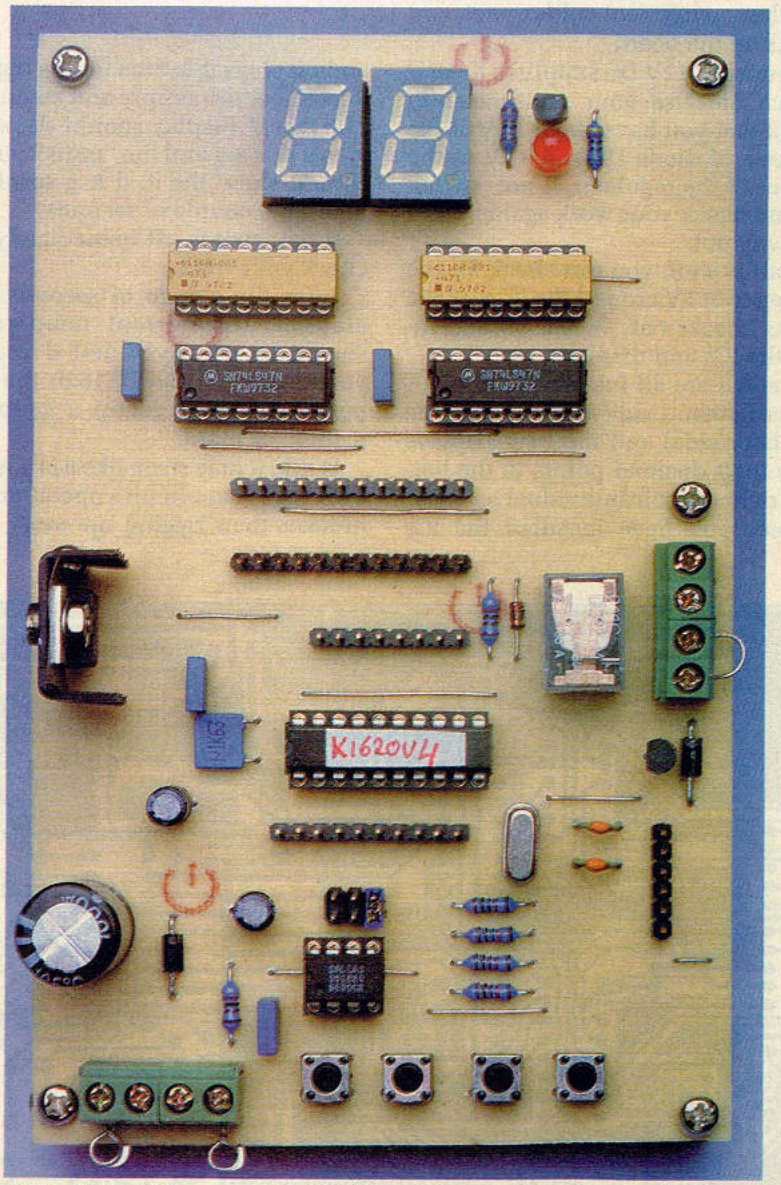
Parts List

1 PC board, 89 x 144mm
1 12MHz crystal (X1)
1 20-pin IC socket
4 16-pin IC sockets
1 8-pin IC socket
2 PC-mount terminal blocks
1 8-way pin header
4 16-way pin headers (cut to length)
3 2-way pin headers
1 jumper shunt
1 20-pin IC socket strip (for LED displays)
1 9V 150mA DC plugpack
1 SPST toggle switch (S1)
4 SPST momentary contact pushbutton (S2-S5), Jaycar SP-0730 or equivalent
1 small finned heatsink (for 3-terminal regulator)
1 12V mini relay (RLY1)

Semiconductors
1 AT89C2051 programmed microcontroller (IC1)
1 DS1620 programmable thermometer (IC2)
2 74LS47 BCD to 7-segment decoders (IC3,IC4)
1 7805 3-terminal 5V regulator (REG1)
1 BC338 NPN transistor (Q1)
1 BC328 PNP transistor (Q2)
2 1N4004 silicon diode (D1,D2)
1 1N914, 1N4148 silicon switching diode (D3)
2 Kingbright SA-52 common anode 7-segment LED displays (DISP1,2)
1 flashing LED (LED1)

Capacitors
1 1000µF 25VW PC electrolytic
2 10µF 25VW PC electrolytics
5 0.1µF 63VW MKT polyester or monolithic
2 27pF ceramic

Resistors (0.25W, 1%)
4 10kΩ 2 8.2kΩ
1 1.2kΩ 1 470Ω
2 470Ω resistor networks (RN1,RN2)



This photo of the completed PC board is reproduced very close to full size so it will be a handy guide to component placement in conjunction with the component overlay.

to constant insertion and removal of ICs.

The LED displays were installed using machine pin IC socket strips. Just cut them to the required length and solder them in. The 7-segment displays are Kingbright SA52 (common anode), available from Jaycar Electronics.

Next, install the power connectors K1 & K8, the relay and 3-terminal regulator. A small finned heatsink should be fitted to the regulator.

Testing

At this stage the board should be ready for testing. Check all your soldering work and make sure that there are no solder bridges between IC pads or other component solder pads and tracks on the board.

Connect a 12V DC supply to K1 and switch on. Use your multimeter to check that you have about 11V at the cathode of diode D1 and +5V at the output of the regulator. If not, switch off and check your work again to find out why not.

If all is well, you can check for the presence of 5V around the IC sockets. If this checks out, switch off and insert the ICs and displays.

The ICs are all inserted with pin 1 to the lefthand side of the board (the regulator side) and the two displays have their decimal points to the bottom right of their individual sockets.

Once you have installed the ICs and displays it is time for the big test. Reconnect the supply and switch on. The "tens" display should show segments d, e & g and the "units" display should show the c, d & g segments, both for a couple of seconds.

If not, switch off immediately and check your work.

After the couple of seconds have elapsed, the current temperature should be displayed and if you put your finger on the DS1620 the temperature should go up a couple of degrees or more.

While it may seem like a crude way of testing your circuit's operation, it is quicker than rigging up some other form of test apparatus. Once you have done this you can cycle through the current T_H and T_L temperatures with pushbutton switch S2.

If you use a brand new DS1620, the current temperature will be the ambient temperature around your DS1620, T_H will be 15°C and T_L will be 10°C. When you return to the current temperature, the display will flash three times to indicate that the current temperature is being shown. This is helpful when all your temperature settings are similar.

The three thermal alarm output pins on the DS1620 should be as follows: Pin 5 (T_{com}) high; pin 6 (T_{low}) low;

Buying The Parts

Some of the key components for this project can be supplied by the designer, Keith Rippon. The prices are as follows:

Programmed AT89c2051	$25
DS1620 programmable thermometer	$15.00
470Ω resistor networks	$1.20 each
12MHz crystal	$3.50

The software listing may also be obtained for $25. Payment may be made by cheque or money order. Please add $5 to your payment for p&p.

Send orders to: Keith Rippon, PO Box 19, Camperdown, NSW 1450.

The PC board may be obtained by contacting RCS Radio Pty Ltd, 651 Forest Road, Bexley, NSW 2207. Phone (02) 9587 3491.

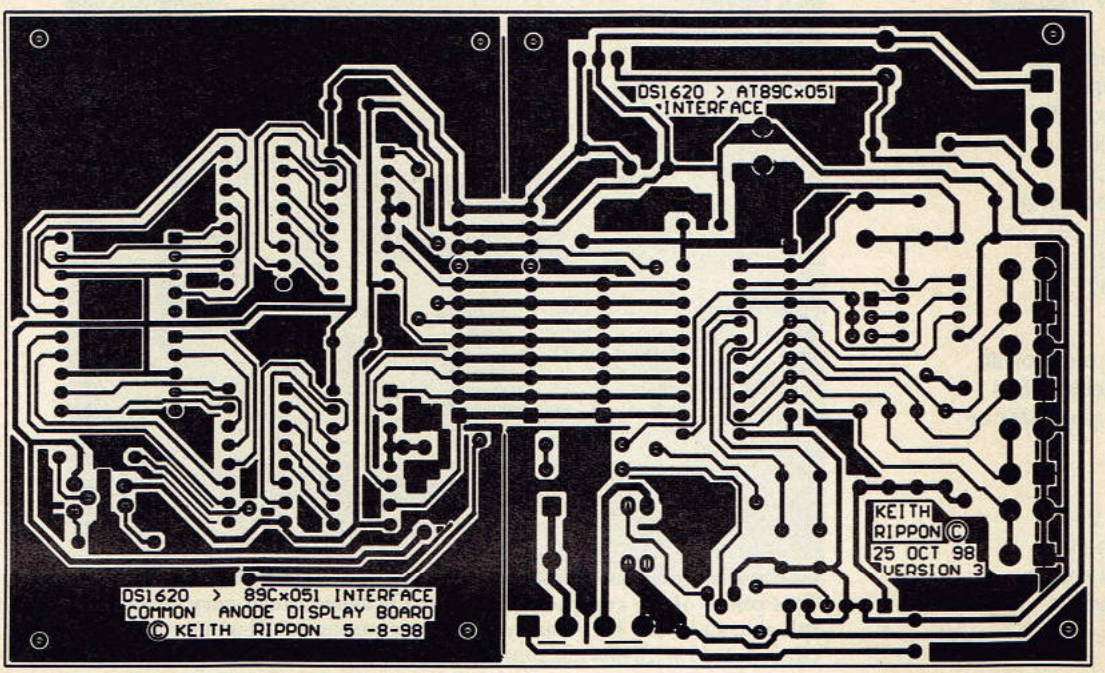


Fig.3: this is the full-size PC board pattern for those who wish to make their own. The pattern is also available from the SILICON CHIP website. You can also use this patern to check commercial boards.

and pin 7 (T_{high}) high.

To program the DS1620, first select either T_H or T_L with pushbutton S2 and then use S3 and S4 to increase or decrease the value.

Keeping S3 or S4 pressed will cause the value to increase or decrease automatically until you let go of the pushbutton. Once you have your values set, use pushbutton S5 to write them to the DS1620's non-volatile memory.

If you decide half-way through that you don't want to change the temperature values just press S2, which will step you back to the current temperature, without altering T_H or T_L.

To put the DS1620 into the stand-alone mode, use pushbutton switch S5. Pressing it once will change the display to '55'. If you are sure you want to put the DS1620 into the stand-alone mode, press S2. If you don't, press S5 again and it will take you back to the current temperature reading. When the DS1620 is in the stand-alone mode the display flashes "00".

If you wish to return to CPU control, just press S2.

Finally, don't forget to switch off before removing the DS1620 from its socket when using it in another application.

When you use the DS1620 in a stand-alone application, don't forget to provide adequate insulation and mounting for it. It won't work well, if at all, when it gets wet or the pins are shorted, etc.

References:

More information about the components used in this design can be obtained from the internet:

- At89c2051; www.atmel.com/
- DS1620; www.dalsemi.com/
- SA52 LED: www.kingbright.com/

This last website is slightly different to the others whereby you navigate around using Acrobat Reader once you get to the data sheet section.

You need Acrobat Reader anyway for the data sheets once you have downloaded them from other sites as they are in .pdf format.

If you don't have Acrobat Reader it is available via the SILICON CHIP web site, www.siliconchip.com.au

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July 1994: Build A 4-Bay Bow-Tie UHF Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; Portable 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper; Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Microphones, Pt.2; Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Build A Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Build A Temperature Controlled Soldering Station; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); How To Plot Patterns Direct to PC Boards.

December 1994: Dolby Pro-Logic Surround Sound Decoder, Pt.1; Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 50-Watt/Channel Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; Remote Control System For Models, Pt.2.

March 1995: 50 Watt Per Channel Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3; Simple CW Filter.

April 1995: FM Radio Trainer, Pt.1; Photographic Timer For Darkrooms; Balanced Microphone Preamp. & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: What To Do When the Battery On Your PC's Motherboard Goes Flat; Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1; Build A $30 Digital Multimeter.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder; Adding Extra RAM To Your Computer.

August 1995: Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; Audio Lab PC Controlled Test Instrument, Pt.1; Mighty-Mite Powered Loudspeaker; How To Identify IDE Hard Disc Drive Parameters.

September 1995: Keypad Combination Lock; The Incredible Vader Voice; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Jacob's Ladder Display; The Audio Lab PC Controlled Test Instrument, Pt.2.

October 1995: Geiger Counter; 3-Way Bass Reflex Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Fast Charger For Nicad Batteries; Digital Speedometer & Fuel Gauge For Cars, Pt.1.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.1; Digital Speedometer & Fuel Gauge For Cars, Pt.2.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.2; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

February 1996: Three Remote Controls To Build; Woofer Stopper Mk.2; 10-Minute Kill Switch For Smoke Detectors; Basic Logic Trainer; Surround Sound Mixer & Decoder, Pt.2; Use your PC As A Reaction Timer.

March 1996: Programmable Electronic Ignition System; Zener Diode Tester For DMMs; Automatic Level Control For PA Systems; 20ms Delay For Surround Sound Decoders; Multi-Channel Radio Control Transmitter; Pt.2; Cathode Ray Oscilloscopes, Pt.1.

April 1996: Cheap Battery Refills For Mobile Telephones; 125W Power Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3; Cathode Ray Oscilloscopes, Pt.2.

May 1996: Upgrading The CPU In Your PC; Build A High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Simple Duplex Intercom Using Fibre Optic Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Installing a Dual Boot Windows System On Your PC; Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-bit Data Logger.

August 1996: Electronics on the Internet; Customising the Windows Desktop; Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Feedback On Programmable Ignition (see March 1996); Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

November 1996: Adding A Parallel Port To Your Computer; 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; How To Repair Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1996: CD Recorders – The Next Add-On For Your PC; Active Filter Cleans Up CW Reception; Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Volume 9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source (For Sound Level Meter Calibration); Computer Controlled Dual Power Supply, Pt.1; Digi-Temp Monitors Eight Temperatures.

February 1997: Cathode Ray Oscilloscopes, Pt.6; PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control; Plastic Power PA Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Audible Continuity Tester; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Avoiding Win95 Hassles With Motherboard Upgrades; Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Teletext Decoder For PCs; Build An NTSC-PAL Converter; Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: Tuning Up Your Hard Disc Drive; PC-Controlled Thermometer/Thermostat; Colour TV Pattern Generator, Pt.1; Build An Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For A Stepper Motor; Fail-Safe Module For The Throttle Servo; Cathode Ray Oscilloscopes, Pt.10.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Simple Square/Triangle Waveform Generator; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers; How Holden's Electronic Control Unit works, Pt.1.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home; How Holden's Electronic Control Unit Works, Pt.2.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; HiFi On A Budget; Win95, MSDOS.SYS & The Registry.

October 1997: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 6-Channel Voltmeter; The Flickering Flame Stage Prop; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Relocating Your CD-ROM Drive; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: A Heart Transplant For An Aging Computer; Build A Speed Alarm For Your Car; Two-Axis Robot With Gripper; Loudness Control For Car Hifi Systems; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Volume 10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 12VAC); Command Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras; Build A One Or Two-Lamp Flasher; Understanding Electric Lighting, Pt.3.

February 1998: Hot Web Sites For Surplus Bits; Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Demonstration Board For Liquid Crystal Displays; Build Your Own 4-Channel Lightshow, Pt.2; Understanding Electric Lighting, Pt.4.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Philips DVD840 Digital Video Disc Player (Review); Understanding Electric Lighting; Pt.6; Jet Engines In Model Aurcraft.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; A Detector For Metal Objects; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Understanding Electric Lighting, Pt.7; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3 (Installing A Modem And Sorting Out The Problems); Build A Heat Controller; 15-Watt Class-A Amplifier Module; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory To Your PC); Build The Opus One Loudspeaker System; Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; A 15-Watt Per Channel Class-A Stereo Amplifier.

September 1998: Troubleshooting Your PC, Pt.5 (Software Problems & DOS Games); A Blocked Air-Filter Alarm; A Waa-Waa Pedal For Your Guitar; Build A Plasma Display Or Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: CPU Upgrades & Overclocking; Lab Quality AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: Silicon Chip On The World Wide Web; The Christmas Star (Microprocessor-Controlled Christmas Decoration); A Turbo Timer For Cars; Build Your Own Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Beyond The Basic Network (Setting Up A LAN Using TCP/IP); Understanding Electric Lighting, Pt.9; Improving AM Radio Reception, Pt.1.

December 1998: Protect Your Car With The Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; A Regulated 12V DC Plugpack; Build Your Own Poker Machine, Pt.2; GM's Advanced Technology Vehicles; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Glider Operations.

January 1999: The Y2K Bug & A Few Other Worries; High-Voltage Megohm Tester; Getting Going With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3; Electric Lighting, Pt.10

February 1999: Installing A Computer Network (Network Types, Hubs, Switches & Routers); Making Front Panels For Your Projects; Low Distortion Audio Signal Generator, Pt.1; Command Control Decoder For Model Railways; Build A Digital Capacitance Meter; Remote Control Tester; Electric Lighting, Pt.11.

March 1999: Getting Started With linux; Pt.1; Build A Digital Anemometer; 3-Channel Current Monitor With Data Logging; Simple DIY PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2; Electric Lighting, Pt.12.

PLEASE NOTE: November 1987 to August 1988, October 1988 to March 1989, June 1989, August 1989, December 1989, May 1990, August 1991, February 1992, July 1992, September 1992, November 1992, December 1992 and March 1998 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or tear sheets) at $7.00 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date is available on floppy disc for $10 including p&p, or can be downloaded free from our web site: www.siliconchip.com.au

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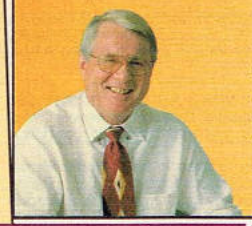


What a fantastic array of bargains to choose from this month, the value packed S 5490 DSC Alarm System, the T 5020 Aluminium Tool Case, T 2600/1 Iroda Gas Irons featuring a BIG 33cc capacity reservoir. Build a quality Solar Powered system with a Powerhouse/Solarex combination plus many more products at HUGE discounts! These and many more products are now available for you to browse on our online catalogue at www.altronics.com.au 24Hrs a day!

Best Regards,
Jack O'Donnell, Managing Director

1.5A Regulated Car Adaptor

Suitable for portable radio, TV, CD Player, Electronics games, calculators, etc.

Simply plugs into your car's cigarette lighter socket, and allows you to power a myriad of appliances. Includes SEVEN interchangeable tips to suit most DC power sockets. Fuse protected. All voltage settings except 12V are regulated, 1.5, 3, 4.5, 6, 7.5, 9, 12V at 1500mA.

M 8620 **$29.95**

PIR Movement Detector

2 Year Warranty

Famous Australian Made NESS Quantum PIR

Features: • Small size • User Selectable Pulse Count On-Off• Dual Element Pyroelectric Sensor • Surface or corner mounting • N.C. Alarm contacts in standby condition • Tamper switch • Adjustable Beam Height Angle • Single pulse or triple count • Exceptional RFI and ESD immunity

1000's sold, and not ONE unit returned! Be aware of cheaper imported products which could cause false triggering and compromise the integrity of your security system!

S 5305 Last Year $49, NOW **$39**

only when purchased with the DSC system.
Buy 2 for ONLY **$65!**

5 Sector DSC Alarm System with Auto Dialler

This system is the same type used by commercial alarm companies.

This alarm can be configured to automatically dial two preset numbers in the event of an alarm. The entire system is controlled and programmed via a keypad.

S 5490 **$299**

Features
- 4 User Codes
- System test function
- 4 Sectors + 24Hr Zone
- Silent Alarm
- Quick Arm
- Zone bypass
- Door Chime
- Battery B/Up

Improve the security of your home or business with this micro-processor controlled alarm, & get $150 worth of accessories FREE!!

Super Bonus Deal!

Purchase a S 5490 5 Sector Alarm system during this month, and we'll supply **$150** worth of accessories **FREE!!!** Bonus package includes W 2346 50m of 4 Core Sec Cable, M 9710 Plugpack, S 5075 Backup battery, S 6130 Siren, S 5445 Blue Strobe, 2 Large alarm stickers and 4 window stickers!

4 in1 Pre-Programmed Remote Control

Can't find the right remote when you need it ? This 4 in 1 is the answer. It combines the functions of your TV, VCR and CATV into just one unit!

This compact remote control can replace up to 4 existing appliance remote controls. It can be configured to control your Television, VCR, CATV & one auxiliary device. ie. A second TV, VCR, etc. To program the functions of your existing appliance into this remote you simply key in the appropriate codes as listed in the handbook provided.

Includes pre-programmed codes to suit all popular makes of Televisions, VCRs and CATV.

Don't spend $100's on an original remote when you can have all the same functions for a fraction of the cost!

A 1005 **$48.95**

Thermometer & Hygrometer

Ideal for use in hydroponics, garden centres, shade houses, monitoring air conditioning , aquariums, wine cellars, etc.

Features • JUMBO LCD displays temperature & humidity • Memory function • -10°C to +50°C temp. & 25% to 95% humidity range with ±5% accuracy • Desk/ wall mounting

A 0155 **$55**

Indoor/Outdoor Hygrometer

Features • Dual display for internal/external temperatures • Memory function • 3m lead • Desk /wall mount

A 0145 **$35**

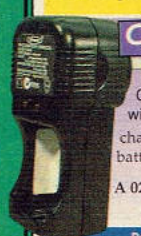
Fantastic for tropical fish aquariums, fish ponds, spas, saunas, home brewing setups.

FLAT WHOPPER WIRE!

Super Low Loss, high quality heavy duty flat speaker cable at a bargain price! Massive power handling, flexible and super tough translucent insulation. Ideal for laying under carpet in your car, home theatre, etc.

W 2140 Normally $110/50m Roll,
SPECIAL INTRODUCTORY PRICE
$100 per 50m Roll

Compact 240V Plug-In NiCad Battery Charger



Charge your batteries in *less than 8 hours* with this versatile charger! Charge either 2 (5hrs charging time) or 4 (7hrs charging time) AA batteries at a time.

A 0285 ONLY **$19.50**

BONUS OFFER For this month, with every A 0285 charger, receive 4 x S 4705 700mAh NiCad Batteries Valued at $10 FREE!!

12" Subwoofer Driver

Just the shot for adding some wallop to your hi-fi, car audio, or home theatre system. This 300mm 8Ω sub driver features a super-rigid Poly Emulsion Coated Cone (PECC), with a high-efficiency foam surround has low-Q, low resonance and high efficiency.

Pmax: 100W RMS, **Fo:** 25Hz
Sensitivity (1W/1m): 92dB
Qts: 0.342, **Vas:** 207.8L
C 3100 Normally $99,
NOW JUST **$65**

WANT BASS? Try this 12" beast for size!

Crimping Tool

This professional quality crimp tool is a fantastic addition to your technical tool kit. With proper care, it will virtually last a lifetime! Suits red,blue and yellow automotive type crimp lugs.

T 1552 Normally $54,
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150+ Assorted Crimps Kit

10ea 6.4,4.5,2.3 Female/Male spade, mini spade lugs, ring terminals, fork lugs, multi-point joiners, 5ea Red/Blue/Yellow inline cable joiners & 5 blue 6.4mm piggyback spade lugs

H 1800 *NOW ONLY* **$13.95**

NiCad Batteries with tags...

...for toys and cordless tools

Sooner or later, your model racing car or cordless drill will stop when the batteries give up. Take advantage of these LOW PRICES to put some life back into your toys and cordless tools!

S 4605 800mAh AA Cell with tags
ONLY **$3.50** ea, or **$3** ea, 10 & up

S 4608 1800mAh C Cell with tags
ONLY **$6.80** ea, or **$6.50** ea, 10 & up

Aluminium Tool Case

This quality aluminium tool case features 5 adjustable dividers for organising your tools and equipment, it also includes 17 tool pockets in the removable lid insert which can be used for smaller hand tools. Supplied with 2 keys and measures 460 x 325 x 150mm. Ideal for technicians, photographers, hire companies, salespeople, etc. *Note: Tools not included.*

Not all tool cases are the same, beware of inferior quality cases.

T 5020 **$65**

Beware of inferior tool cases with plastic sides! The Altronics T 5020 Tool Case has all aluminium panels!

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POWERHOUSE INVERTERS

Operate 240VAC appliances from a 12 or 24V battery ANYWHERE, ANYTIME!!

efficient and will deliver high surge currents. The auto-start mode enables the inverter to remain connected to the battery(drawing only micro amps) and springs into life once you turn on your equipment, saving precious battery power. Some uses are camping, boating, fishing, mining, farming, & remote settlements.

Features: • Dual AC Power Sockets • Auto-start standby mode • Sturdy rust proof ABS case • Heavy duty battery leads • LED status • Circuit breaker protection (600W & 1200W models)

All models now include PHASE CORRECTION to run inductive loads. ie.fridges, pumps, small motors,etc.

K 6755 300W 12V Input
K 6756 300W 24V Input **$449**

K 6777 600W 12V Input
K 6779 600W 24V Input **$749**

K 6797 1200W 12V Input
K 6799 1200W.24V Input **$1079**

Solarex® Solar Panels

NEW

Made in Australia

10 Year Warranty

Designed for the harsh Australian outback, all models incorporate a robust low profile aluminium frame enabling them to be mounted on the roof of Caravans or Boats, etc without protruding above the vehicle causing undue drag. They provide 12V DC output with the exception of the N 1030, N 1050 and N 1080 which are easily configured for 6 or 12 volts. This allows the modules to be configured to meet any design requirements and enabling bypass diodes to be added to prevent damage to the panel if required. Various voltages can be produced by connecting the modules in a series or parallel configuration.

FANTASTIC FOR BOATING, CAMPING, CARAVANS, REMOTE AREA POWER SYSTEMS, RECREATION VEHICLES & 4WDs

Part No	Power (Watts)	Weight (Kgs)	Dimensions(mm) H	W	D	RRP
N 1005	5	0.77	250	269	23	$160
N 1010	10	1.5	420	269	23	$195
N 1020	20	2.5	416	500	23	$290
N 1030	32	3.5	588	660	23	$350
N 1050	53	5.5	933	660	23	$515
N 1080	80	9.5	1105	660	50	$745

*Power rating are quoted at STC of 1000 W/m2 & 25°C cell temperature

6.5A Solar Panel Regulator

N 2060 **$95**

Most photovoltaic panels require an external regulator to avoid the overcharging of batteries.
Features: • Reverse polarity protection • Temperature compensation • *PWM* Pulse Width Modulation charging • LED indicator and is housed in a rugged all aluminium case • Encapsulated in epoxy for a durable weather resistant seal to suit any conditions. • 5 Year Warranty

PIR Door Minder & Alarm

Ideal door minder for shops, automatically announces when customer arrive! Similar models sell for over $100 or more!

An excellent DIY unit for use in home, office, shops,etc. Two modes of operation: • Entry/exit chime activated by an external switch or by movement detected by the PIR. • Alarm mode, when activated the alarm sounds for 30 seconds. *Features:* • 10 Metre detection range • Simple and easy to install • Self-contained unit • Swivel mount bracket • Remote doorbell contacts • Doorbell only operation when in Off mode • Ideal as a travellers intruder alarm

S 5320 **$39.95**
M 9600 9V DC Plugpack to Suit **$13.50**

19 Range Digital Multimeter

This DMM is small enough to literally fit into your pocket! Great for the trades person on the move, or for a student lab kit. Includes an audible continuity buzzer, 'K' type thermocouple, and square wave test signal output. Measures DC Volts to 1000V, DC Amps to 10A, AC Volts to 750V, resistance to 2MΩ and temperature from -20°C to 1370°C. It even includes a diode test function! Measuring only 70 x 126 x 25 mm and weighing only 170g, this meter is a pocket rocket with a price to match!

Q 1051 Was $29.95, NOW JUST **$20**
Q 1054 Carry Case ONLY **$5**

Includes Temperature Probe & Thermocouple for Measurements up to 1400°C!

Laser Pointer

Maximum Permitted Power Output 1mW

This little keychain unit is also ideal for lectures, seminars, building sites, guided tours, and it's much less intrusive than a standard "stick" type pointer. Uses three button cells (included). Complies with new regulations governing the output power of laser pointers. (< 1mW output). (refer to *Batteries* section, for S 5002/S 5013 to suit)

A 0205 **$19.95**

NEW LOW PRICE FOR 1999!

33 Pcs Driver Bit Sets

The Holy Grail of screwdriver bit sets!

All housed in a handy plastic holder. Great for the toolbox, workbench, etc. Suitable for use with battery drills or most hex bit drivers.

T 2182 Driver Set contains: • 5 Slotted, 3, 4, 5, 6, & 7. • 8 Phillips, #0, 2 x #1, 3 x #2, 2 x #3 • 7 Pozi, 2 x #1, 3 x #2, 2 x #3 • 6 Hex (Metric), 2, 2.5, 3, 4, 5, 6. • 6 Star, 10, 15, 20, 25, 30, 40. • 1 Magnetic Bit holder

T 2180 Security Bit Set contains: • 4 Triwing, 1, 2, 3 & 4. • 9 Torx, T8, T10, T15, T20, T25, T27, T30, T35 & T40. • 4 Snake Eye, 4, 6, 8 & 10. • 12 Hex Metric 2, 2.5, 3, 4, 5 & 6. Imperial 5/64", 3/32", 7/64", 1/8", 9/64" & 5/32". • 3 Torque, 6, 8 & 10 • Magnetic hex extension bar

T 2182 **$13.95**
T 2180 **$13.95**

BONUS! Buy Both sets for $26

1.5A Regulated Supply

Includes Short Circuit, Thermal & Overload Protection!

This compact sturdy power supply is capable of delivering a constant 1.5A at 3V,4.5V, 6V, 7.5V, 9V and 12V. Being regulated, the output voltage varies only minimally from full load to no load making it ideal for voltage sensitive devices like portable TV sets, video games, tape recorders, radios, scanners, computers. Features a mains on/off switch, power on indicator and binding post connections.

M 8230 Normally $49, NOW **$39.95**

Intelligent UHF Remote Control

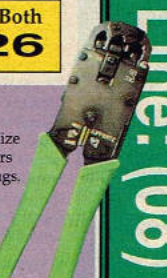
This miniature intelligent *learning* remote control can be used as a replacement for your car remote control or to combine more than one remote. ie. Garage door, car, motorbike, home alarm, etc.

Features: • Four programmable buttons • Easy to program • Wide operating frequency range of 255-500MHz • Includes alkaline battery

Put your car alarm and garage door opener on one handy remote!

A 1015 *ONLY* **$39**

Pro Crimping Tool



This heavy duty, all metal deluxe tool will crimp all size modular plugs from 4 to 8 way. Also has inbuilt cutters and wire stripper that strips to accurate length for plugs.

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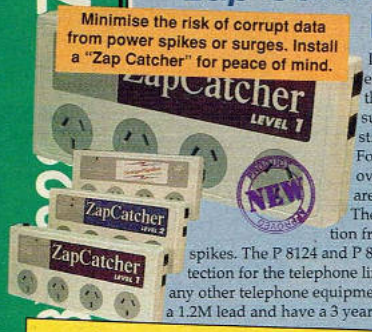

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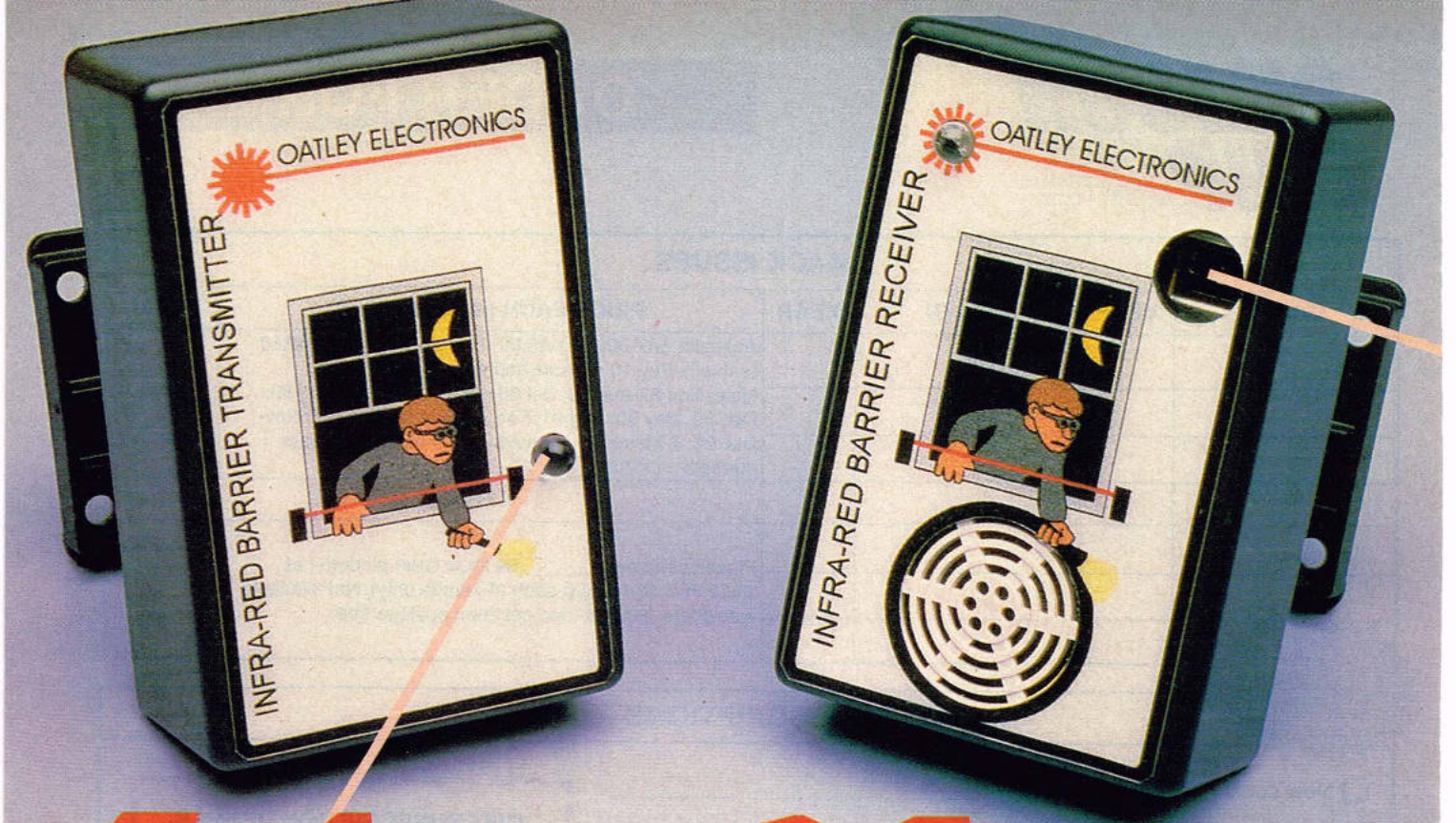


Infrared Sentry

If you have a doorway, passageway, window or pathway – up to 25 metres wide or even more – this nifty little project will stand guard for you. If anyone dares intrude on its domain it will scream long and loud!

There are many situations where we would like to be warned if anyone is present. Immediately, of course, we think of security applications – intruder alarms, for example. We really do need to know if someone has entered an area where they shouldn't be. Some form of detection and warning is vital.

But there are other uses for a detection system, not necessarily used in anger! The classic shop door buzzer is a good example – if the shopkeeper is busy or in the back office, he or she might not notice a customer entering. Customers don't like being kept waiting . . . and then there are those who might not be paying customers at all, just waiting for an unattended counter.

Closer to home, you might like to know if visitors are coming towards your door long before they ring the door bell. Advance warning will give you the chance to quickly tidy the room or perhaps turn the music down so they'll go away!

There are many other applications but we're sure you get the picture.

Having said all that, how are we going to detect these intruders/customers/visitors/salesmen/etc?

Design by Branco Justic
Article by Ross Tester

We could use a passive infrared detector or microwave sensor. While very effective, they are not particularly easy to camouflage and most really aren't suitable for outside use. Not only that, they are relatively expensive

Under-carpet pressure mats have been used for many years but these have fallen out of favour, again mainly due to cost but also because of their propensity to be damaged, even under carpet (stiletto heels were a real killer – literally – for pressure mats!)

How about that good ol' shop door buzzer we mentioned earlier? Well, until now we probably would have dismissed this idea as well, because of the rather high cost of such units.

But now there's a build-it-yourself alternative which is not only low in cost, it's rather more versatile than the traditional light beam detector.

Most of the light beam detectors we've seen have used a transmitter and receiver housed in one unit, with the light beam leaving the transmitter, hitting a reflector and bouncing back to the receiver. While effective, range was somewhat curtailed by the fact that the light had to travel twice the distance.

This new design uses a separate transmitter and receiver, both housed in small (82 x 53 x 30mm) jiffy boxes. The prototypes also had universal mounting brackets attached to the boxes but these could be regarded as optional – mounting suits the application.

The circuits

While the circuit diagram of Fig.1 is shown as a complete system (transmitter and receiver) it really is two independent components and we will discuss it that way, starting with the transmitter.

The heart of the transmitter is an infrared light emitting diode, IRLED1. Unlike a conventional LED, this produces no visible light when forward biased. Therefore there is nothing intruders can do to tell that there is a beam of infrared light across their path.

As a matter of interest, the old smoke-across-the-beam trick you often see in spy movies and the like simply doesn't work with infrared light – unless, of course, there is an element of visible light (usually red 'cause it looks good on the screen) also in the beam. There is no visible light at all from this IR LED.

The infrared LED cannot be constantly turned on otherwise the detector in the receiver would not work. It is pulsed at about 38kHz. IC1a and IC1b (two of the gates from a 4093 quad 2-input Schmitt NAND gate) and their associated components form an oscillator at about 38kHz. You may wonder why two resistors (R2 & R3) are specified: these set the oscillator frequency and R3 allows tweaking if required. In practice, the system is quite forgiving and adjustment is not needed. Still, it can be done.

You will also note another oscillator formed by R1, C1 and IC1d. This one runs at about 400Hz (again, not critical) and this "data stream" is impressed on the 38kHz "carrier" by the fourth gate in the chip, IC1c.

Zener diode ZD2, transistor Q1 and associated components form a switched constant current source which feeds the infrared LED, IRLED1. Therefore the LED is pulsing at 38kHz modulated by 400Hz – which, of course, you cannot see unless your eyesight is the same as some birds!

The peak current through the LED, set by R7, determines the range of the overall system.

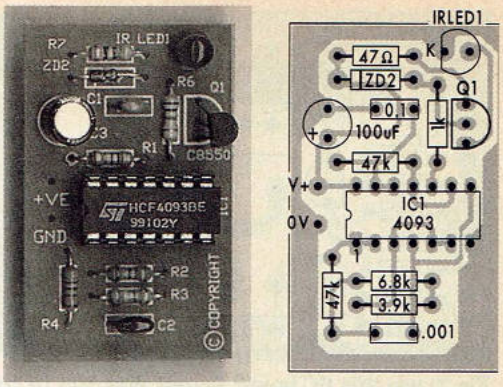
As supplied, with a value of 47Ω, the range is about 17 metres. Reducing this resistor to 22Ω should increase the range to more than 25 metres.

There is a trade-off, though, in gaining extra range in this manner: a transmitter power significantly greater than that required for operation over the range required may cause the beam to be reflected around the room from other objects. It is possible that more than one beam path is formed and the receiver may then not respond when the required beam is cut.

There are other simple ways to increase range – much more dramatically – which we will discuss shortly.

Hang on a second! Why would you want a range to 25 metres or more anyway? That's one big window or doorway . . .

The reason is that this project can also be used as a perimeter alarm. With three small mirrors to reflect the beam 90°, you could go right around the wall of a small warehouse, store-



The transmitter PC board is tiny – this component layout and photograph will help you assemble it.

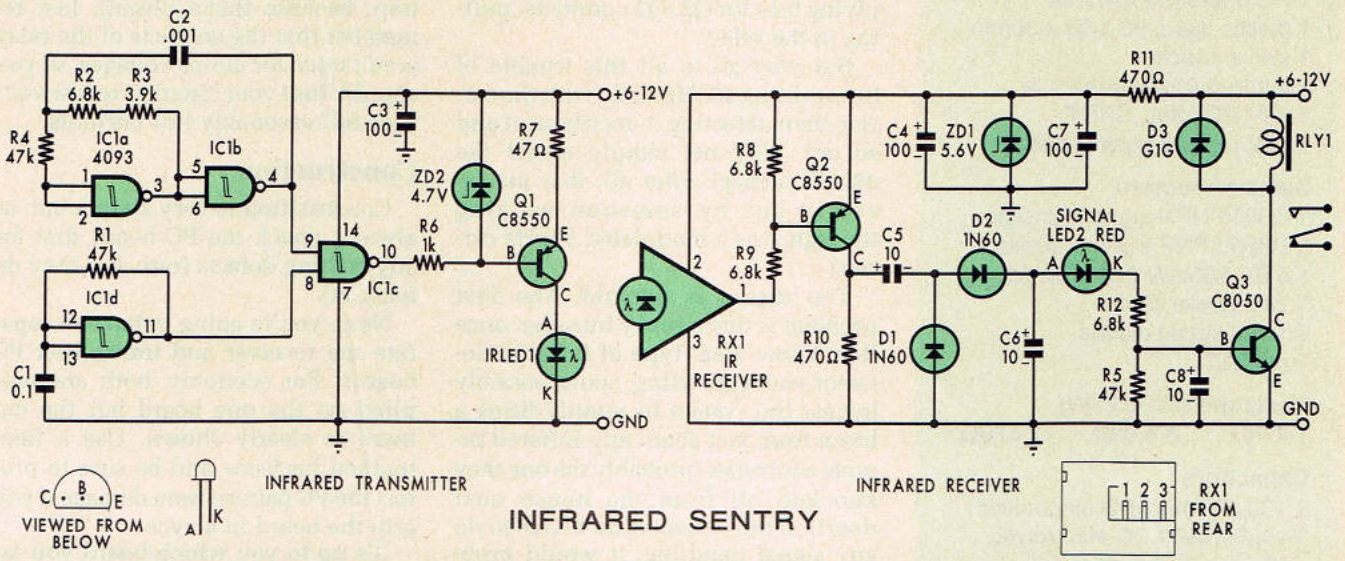


Fig.1: both the transmitter and receiver are shown in this combined circuit diagram. The optional piezo buzzer is not shown here but if used, simply connects to +12V and GND via the relay contacts.

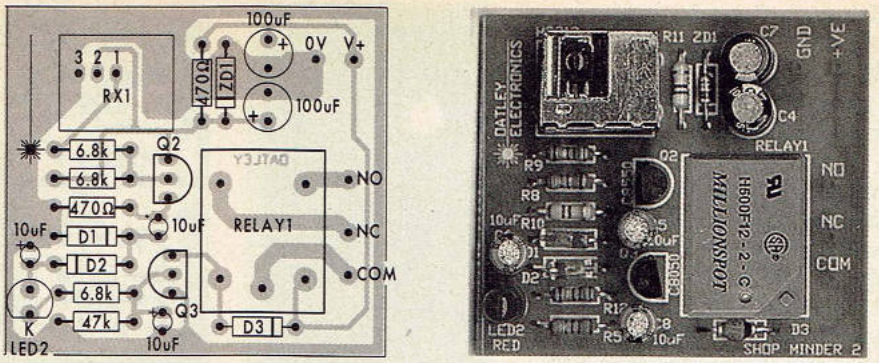


Fig.2: use this PC board layout diagram in conjunction with the photograph above to help assemble the receiver PC board.

Parts List

TRANSMITTER

1 PC board, 30 x 47mm*
1 plastic case, 82 x 53 x 30mm
1 swivel bracket
1 14-pin DIL IC socket

Semiconductors

1 infrared LED
1 4093 quad 2-input Schmitt NAND gate
1 C8550 PNP signal transistor
1 4.7V 400mW zener diode

Resistors (5% 0.25W)

2 47kΩ 1 6.8kΩ 1 3.9kΩ
1 1kΩ 1 47Ω

Capacitors

1 100µF PC electrolytic
1 0.1µF polyester
1 .001µF polyester

RECEIVER

1 PC board, 52 x 47mm*
1 plastic case, 82 x 53 x 30mm
1 swivel bracket
1 infrared receiver module
1 12V PC relay, SPDT
1 12V piezo buzzer (optional)

Semiconductors

1 C8050 NPN signal transistor
1 C8550 PNP signal transistor
1 5.6V 400mW zener diode
1 GIG power diode
2 1N60 signal diodes
1 red LED

Resistors (5% 0.25W)

1 47kΩ 3 6.8kΩ 2 470Ω

Capacitors

2 100µF 16VW PC electrolytic
3 10µF 16VW PC electrolytic

* supplied as one board

room, office, etc to catch anyone breaking in any window or door, or even through the wall itself!

The receiver

Just as the heart of the transmitter is one dedicated component, so the heart of the receiver is RX1, a dedicated infrared receiver module.

This module has just three connections – two for power and an output. While ever a valid infrared signal (ie, 38kHz) is being received, the output voltage remains low. Transistor Q2, therefore, conducts. However, it's not just the 38kHz signal that's being received – the 38kHz is modulated by the 400Hz signal. The module passes this 400Hz signal which appears at the collector of Q2.

Following Q2 is a voltage-doubling rectifier circuit (D1 & 2, C5 & 6) which converts the 400Hz AC signal to DC. LED2 is then forward biased, not only lighting itself in the process but supplying bias for Q3. Q3 conducts, pulling in the relay.

But why go to all this trouble of transmitting 400Hz along with the carrier, then detecting it, rectifying it and so on? Why not simply detect the 38kHz carrier? After all, it is just as surely cut by someone walking through it as a modulated 38kHz carrier?

The reason is twofold. The first problem is that a savvy intruder, once they knew what type of infrared detector you were using, could possibly bypass the system by simply firing a beam from just about any infrared remote controller (probably the one they knocked off from the house next door!). If the system didn't have to do any signal handling, it would probably react to any infrared signal, regardless of encoding.

Second, and a little more down-to-earth, is that the system could be prone to either electrical or even light-induced noise if operated in a simple mode. As it is, the circuitry is quite good at rejecting noise and is quite reliable.

OK, that's what happens when the receiver is receiving. What happens when someone cuts the beam?

Very little! The output of the infrared module goes high, cutting off Q2. Therefore there is no signal at Q2's collector, so LED2 and Q3 lose their bias. When that happens, the relay drops out.

To ensure no harm is done to Q3 or other semiconductors, a diode is connected across the relay coil. When Q3 stops conducting and the field around the relay coil collapses, a quite high voltage spike can be induced in the coil, with opposite polarity to the voltage which powered the coil originally. This forward biases D3, effectively shorting the coil.

In the prototype, a low voltage piezo buzzer was glued into the case and connected between the positive and negative supply with the appropriate relay contacts in series. This is reminiscent of the shop door buzzers of old – the buzzer sounds when ever anyone cuts the beam. If you walk slowly enough through the beam, it actually sounds twice. Guess why? Oh, come on, it's not that hard . . .

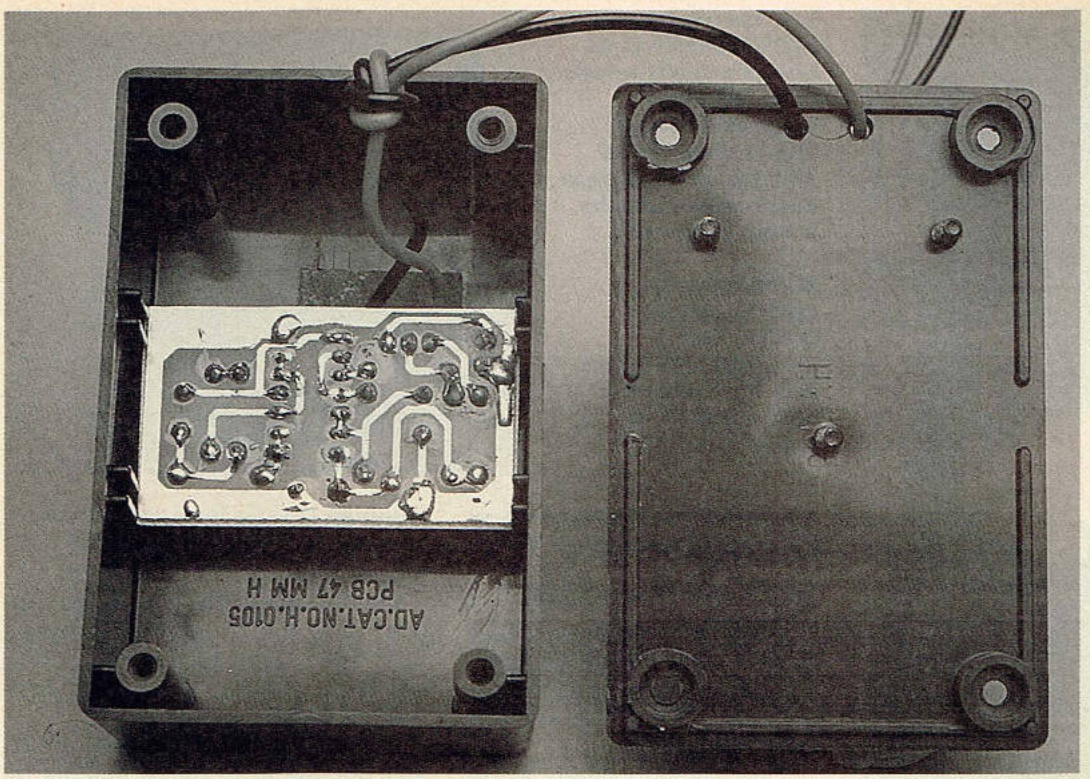
Of course, you don't need to fit a buzzer. You can wire the relay contacts to do just about anything you want to (short of setting off a man trap, because that's illegal). Just remember that the contacts of the relay aren't rated for mains voltages, so you should limit your circuitry to low voltage and reasonably low currents.

Construction

Construction is very simple but, as always, check the PC board first for any etching defects (rare, but they do happen).

Next, you're going to have to separate the receiver and transmitter PC boards. For economy, both are supplied on the one board but the cut mark is clearly shown. Use a fine-toothed hacksaw and be sure to protect the PC pattern from damage if you grip the board in a vyce.

It's up to you which board you assemble first. All component positions are clearly marked but take care when



This photo shows the method of mounting the transmitter PC board in its jiffy box. The board snaps into place on lugs moulded into the box walls with no screws or nuts needed. Holes must be first drilled in the case for the IR LED and also the power leads. Note that these photos show early prototypes.

placing any polarised components. There are a couple of side-by-side components which are opposite-way-around to each other. Also make sure you don't mistake the power diode, small signal diodes and zener diode.

It is possible, though difficult, to insert the infrared detector module the wrong way around. Pinouts are marked on the circuit and on the PC board. To be safe, we would leave the detector until all other components are inserted and soldered in.

Testing

If you're going to use the piezo buzzer, we strongly suggest you leave it until the very last thing, or at least heavily muffle it! It's very annoying to have it going off all the time while setting it up.

Testing is probably easiest carried out before mounting the assembled PC boards in their jiffy boxes.

Connect a 12V supply (a battery is fine) to both the transmitter and receiver boards and aim one at the other. You should hear the relay click in when they are aimed at each other and drop out when you turn either one away.

If that happens, you can proceed to mount the boards in their cases. The photographs give a good idea of how this was done. You may have other ideas, particularly if you have a specific location in mind which requires some ingenuity!

If they don't work? One board at a time, carefully check your soldering (especially bridges between close contacts) and component placement/orientation.

If all appears OK, check voltages. The supply to the IR receiver module (pin 2) should be about +5.6V (plus or minus a tad). On the transmitter board, the easiest voltage check (after the supply, that is) is the voltage across ZD2 – about 4.7V.

If basic voltages appear OK, check the output voltage from pin 1 of the receiver module. With the transmitter firing, it should be about +2.5V. With no transmitter, it should be about +5.6V.

If these voltages are OK, the error is further down the track – possibly Q2 or Q3 are inserted the wrong way around (though that's hard because the orientation is shown on the PC board overlay).

Perhaps D1 or D2 are back-to-front? If you suspect the relay, that can be checked by carefully shorting Q3's collector and emitter. It should pull in.

Mounting the boards

Even if you buy the complete kit, the jiffy boxes supplied will not be drilled. The boxes are actually used upside-down – the lid of the box becomes the base. You will need to drill holes in the bottom of the receiver box for the infrared receiver module, the signal LED and the piezo (if used). The power supply wires, along with any external connection wires, can emerge through suitable holes drilled in the box lid.

Similarly, the transmitter will need a hole for the IR LED and a pair in the lid for the power wires.

The prototype boxes also had swivel mounting brackets attached to the base (ie, the box lid) to make mounting and aiming much simpler. At the price, we think they're good value.

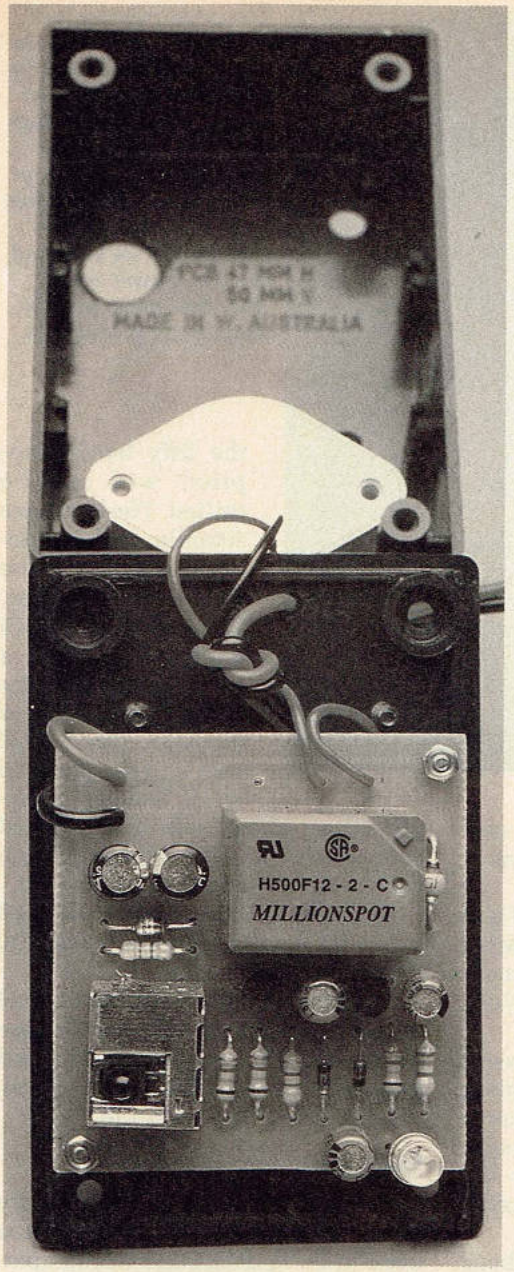
Mounting the system

Assuming you've used the jiffy boxes and swivel brackets, all you need to do is determine which aperture you want to protect with this system, mount the units so that they face each other – and that could be it.

When you apply power there should be a brief squeak from the piezo buzzer and the system will sit there until the beam is broken, at which time the buzzer should squark its head off!

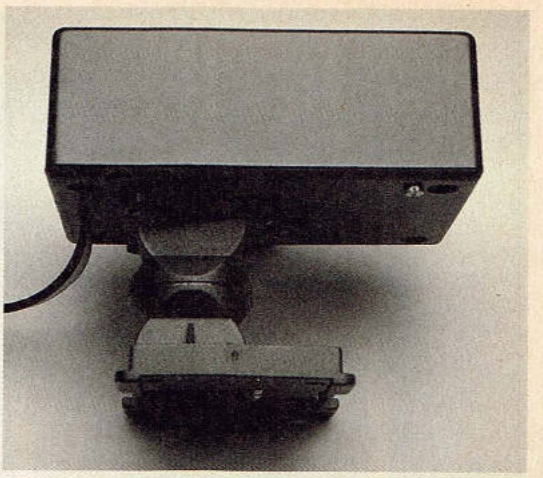
If you haven't used the jiffy boxes and brackets, you'll need to work out a method of mounting. But it's straightforward – as long as the IR LED points to the IR receiver (and as long as they're not too far apart) the system should work.

By the way, when protecting a passageway or similar access route, it's normal to mount the system down low (to catch anyone crawling) but



Left: the receiver PC board mounted in its case (it actually screws to the lid which becomes the base!) This is shown fitted with the optional piezo buzzer, glued into the bottom of the case.

Right: using the optional swivel bracket makes mounting and aiming both the transmitter and receiver a lot easier.



not so low as to have pets or other small animals set it off.

Increasing the range

We mentioned before a range of up to 17m should be possible with the units as described, or 25m if R7 in the transmitter is reduced to 22Ω.

This is a pretty handy sort of range, you'd agree. But wait, there's more!

If fitted with simple optics, the range can be dramatically increased. A simple glass lens placed at the focal point of the IR receiver module will give you double, triple and even more range. The same thing applies to a lens at the focal point of the IR diode.

Alternatively, using a parabolic reflector will also give an amazing increase in range. In this case, the IR LED and the IR receiver are turned around to face into the reflectors and are mounted at their focal point. Aiming becomes a little more tricky over longer ranges but it can be done.

Finally, while the system is relatively free from the effects of ambient light, any system such as this is usually improved with the used of internally blackened tubes.

Neither length nor diameter are really important. If you're looking for very cheap tubes, try toilet roll holders. **SC**

Where To Buy The Parts

Parts for the Infrared Sentry are available from Oatley Electronics. The PC board(s) and all on-board components with the exception of the relay are $17.00 while the relay and buzzer are each priced at $3.00

To complete the project, a set of two jiffy boxes, complete with swivel brackets and labels, is available for $6.00. Oatley Electronics' phone number is (02) 9584 3563; fax (02) 9584 3561; email oatley@world.net

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14 Model Railway Projects

THE PROJECTS: LED Flasher; Railpower Walkaround Throttle; SteamSound Simulator; Diesel Sound Generator; Fluorescent Light Simulator; IR Remote Controlled Throttle; Track Tester; Single Chip Sound Recorder; Three Simple Projects (Train Controller, Traffic Lights Simulator & Points Controller); Level Crossing Detector; Sound & Lights For Level Crossings; Diesel Sound Simulator.

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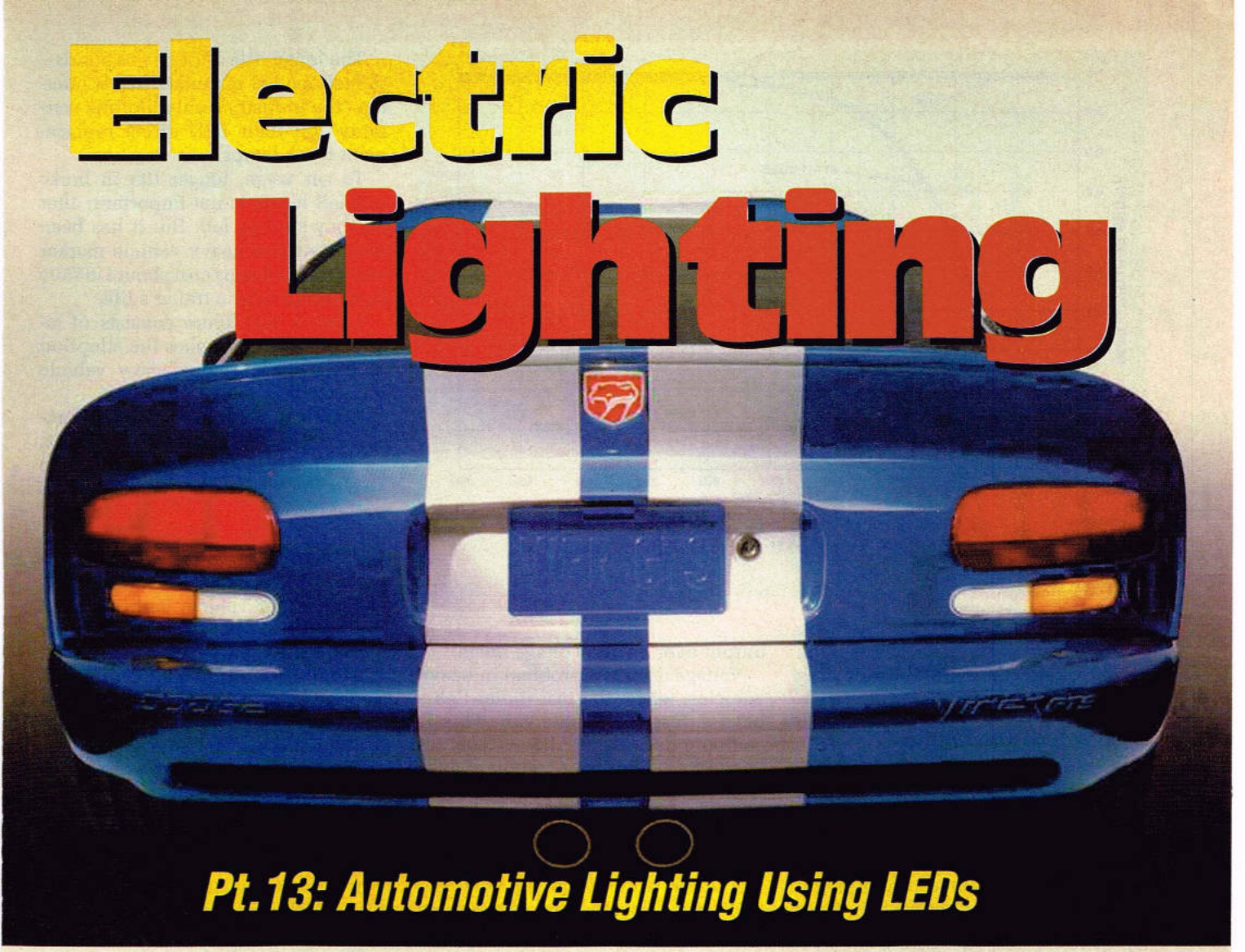
Electric Lighting



Pt.13: Automotive Lighting Using LEDs

Light emitting diodes (LEDs) have particular advantages over incandescent lamps when used in the brake, tail and indicator lights of vehicles. They last longer, are more efficient, have better vibration resistance and they turn on faster.

By JULIAN EDGAR

When used in brake lights, the faster turn-on time of light-emitting diodes when compared with incandescent lamps gives drivers in following cars significantly more time to react and apply the brakes.

Incandescent brake lamps have turn-on times of up to 300ms. In that time, a car travelling at 60km/h will travel 5 metres – or about one car length.

By comparison, a LED has a turn-on time of 100ns (one tenth of a microsecond) which is negligible.

Fig.1 gives a graphic comparison of the turn-on times for a typical incandescent brake light and the LED equivalent.

Note that this assumes that the full battery voltage is available but in a typical brake light circuit significant voltage drops are often present. These make the turn-on time worse, often much worse.

With a voltage drop of 4V in the braking circuit, the turn-on time of an incandescent automotive bulb can double and the brightness is greatly reduced.

Both factors mean that the reaction time of the following driver is greatly increased.

Studies have shown that LED brake lights provide a reduction in driver response time of between 170 and 200ms under favourable road conditions and up to 300ms under adverse conditions.

In addition, practical testing has shown that the response time of a person viewing a LED brake light is actually faster than expected, even taking into account the much shorter LED switch-on time.

It is thought that because it reaches

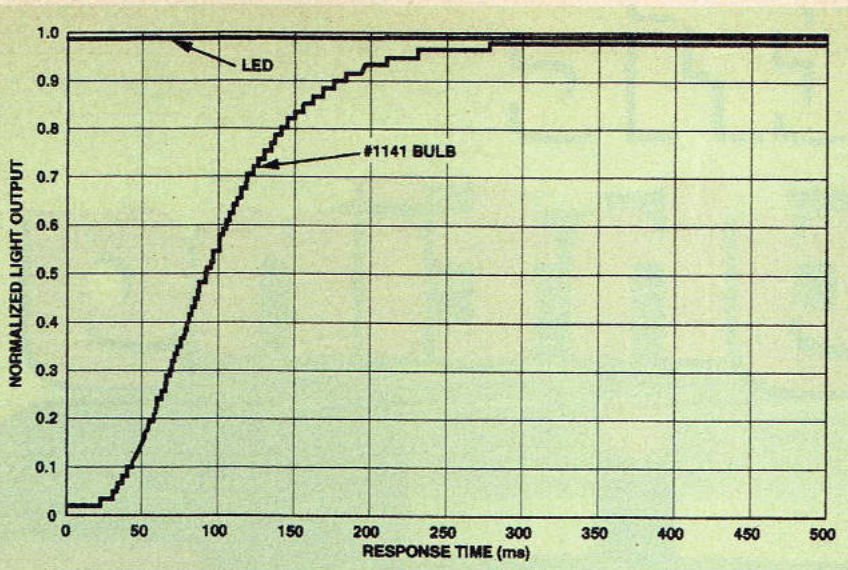


Fig.1: turn-on times at 12.8V for a typical incandescent brake light and the LED equivalent. Note that the LED effectively turns on instantly. (Hewlett Packard).

full brilliance very quickly it is more likely to catch the eye of the following driver.

Tail & marker Lights

While cars have used high intensity red LEDs in rear spoiler brake light arrays since 1986, they have been little used elsewhere.

Now, drop-in replacement LED tail and marker lamps for trucks and semi-trailers have been introduced. In these applications, the benefits of LEDs include shock and vibration resistance, less current drain and constant light output over a wide voltage range.

Voltage drop is a problem in heavy vehicles, where the rear trailer lights have a very long cable run. This is compounded where ABS systems are to be fitted. For the operation of anti-lock brakes on trailers, at least 9.5V must be available.

For older B-double and triple trailer combinations being upgraded to ABS, the easiest way of making sure that 9.5V is available, short of re-wiring the trailer with heavier cable, is to reduce the total current drain by using LEDs.

The longer life of LEDs is a bonus – in fact one US manufacturer is offering "the industry's only lifetime warranty" on their LED direct replacement truck lamps.

To car users, longer life in brake and tail lamps is not important; after all they seldom fail. But it has been estimated that heavy vehicle marker or clearance lamps cost about US$500 to maintain over a trailer's life.

Most of this figure consists of labour costs and it makes the adoption of LED lights in the heavy vehicle industry very attractive.

American Freight-ways of Arkansas, USA is currently specifying LEDs for the red three-lamp cluster located above the rear door of 5,000 of its trailers.

All-LED Lights

The adoption of LEDs for all external passenger vehicle lamps (except the headlights) is expected to occur over the next few years.

At only 50mm thick, LED light assemblies can be much thinner than incandescent lamps, which can be up to 150mm deep. However, the biggest advantages remain lower power consumption and the increased life.

LED manufacturer Hewlett Packard recently surveyed 17 1998 US-market cars and trucks. The total power for incandescent signal lamps varied from 93 - 217W for daytime operation and from 135 - 263W for night use.

They then calculated the required number and type of LEDs to replace

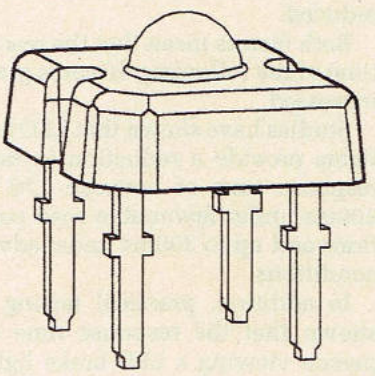


Fig.2: Hewlett Packard's Super Flux LEDs are designed expressly for motor vehicle lamps. The LED body is 7.6mm square. (Hewlett Packard).

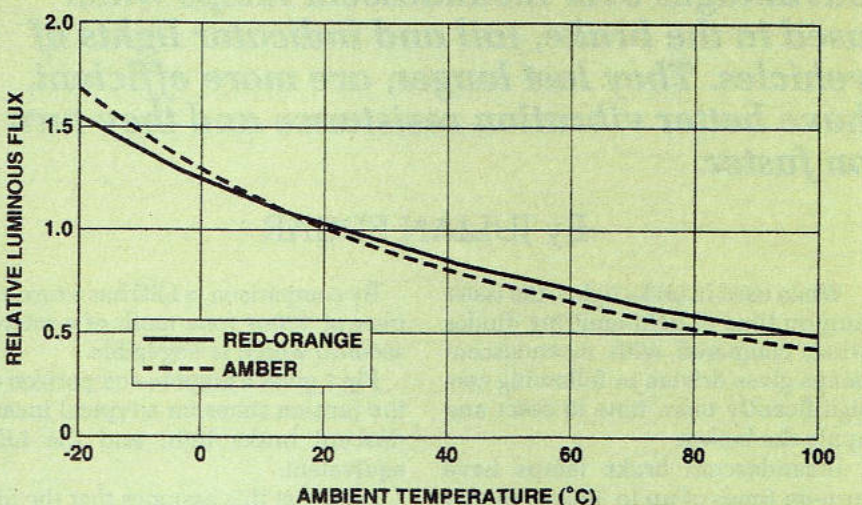


Fig.3: the luminous flux output characteristic of a Hewlett Packard AlInGaP LED. At 75°C the luminous flux is reduced to half of that developed at 20°C. (Hewlett Packard).

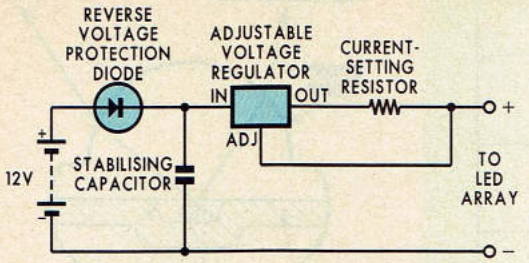


Fig.4: LED current can be kept constant irrespective of battery voltage variations by the use of a constant current drive circuit. This eliminates the increased LED heating that otherwise occurs at times of high battery voltage. (Hewlett Packard).

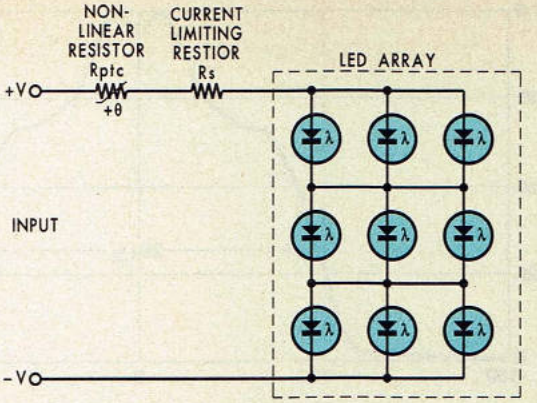


Fig.5: to avoid over-heating the LEDs, it is common practice to use a PTC resistor to reduce the current at high ambient temperatures. (Hewlett Packard).

these incandescent signal lamps. For the exercise, the LEDs were connected in series strings with four LEDs per string.

Each string was driven at 60mA with the current set by a resistor. The potential power savings were about 80% for daytime running and 78% at night.

Next, HP calculated the proportion of time that each of the lights would be on. For example, if a car is driven entirely in urban conditions, they suggest that the brake lights will be operating 25% of the time, the turn indicators 1.4% and the 'parking' (ie, tail lights and front marker lights) 30% of the time.

The use of LEDs in centre high mount stop lamps has become common. The fast switch-on time of LEDs gives following cars significantly more time to stop. (Hewlett Packard).

From this they calculated the reduction in the power rating of the alternator for a car equipped with LED signal lights.

Taken in conjunction with the lighter gauge wire that could be used in a LED installation, a very small reduction in overall vehicle mass could be made. However even this small reduction had worthwhile benefits in fuel consumption figures.

Another advantage of LED turn signals is that their reduced power consumption allows much longer operation of the hazard flashers before the battery is flattened.

At a 50% duty cycle, the average current hazard flashers using incandescent lamps is 4.7A. This can be reduced to 2.3A if LEDs are used. Thus the use of LEDs could more than double the length of time the hazard flashers could be operated without the engine running.

Automotive LEDs

Hewlett Packard's recently released Super Flux LEDs are designed expressly for automotive exterior lighting. They feature a high light output (3000 millilumens at 70mA) and have an operating temperature range of -40°C to 100°C.

They also meet the colour requirements for automotive signal lighting as specified by the appropriate regulating bodies. The LEDs use AlInGaP construction and have a low profile package.

Fig.2 shows an outline drawing of the new LED.

There are two major design considerations that must be made when de-

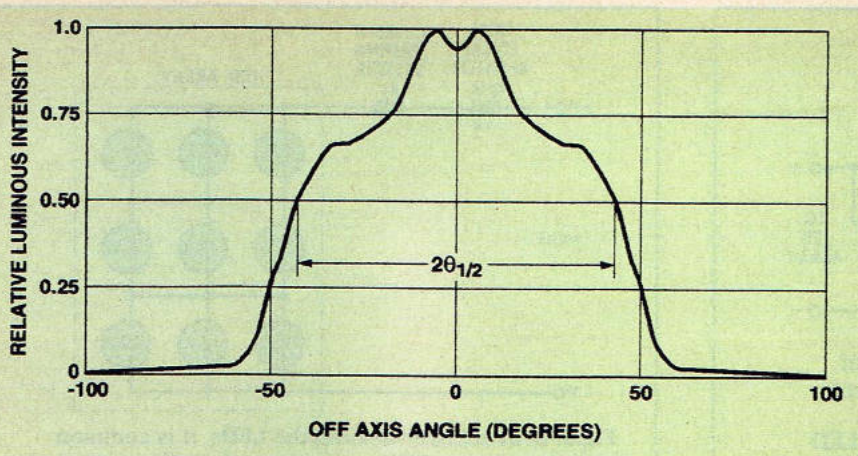


Fig.6: the light flux distribution of a Hewlett Packard Super Flux LED is symmetrical around its optical axis. Luminous output falls to nearly zero at angles of more than 50 degrees to the optical axis. (Hewlett Packard).

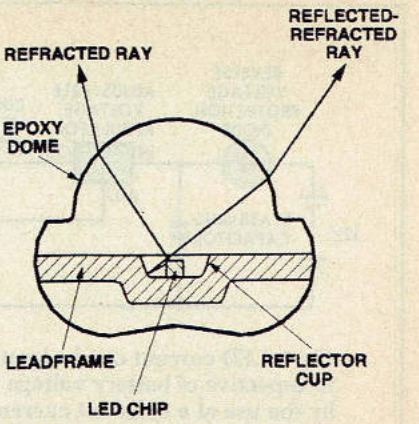


Fig.7: the light output of a LED both refracted and reflected-refracted light. (Hewlett Packard)

veloping LED automotive lights. These are:

- control of heat; and
- management of the light output by lenses and reflectors.

Heat control

As discussed last month in this series, the light output of LEDs declines with increasing temperature.

Fig.3 shows the output characteristics of a Hewlett Packard AlInGaP LED. It shows that light output at 75°C is half that produced at 20°C.

This is important since maximum temperatures of 70°C are common within exterior high-mounted central brake lights, while interior-mounted lamps can go as high as 90°C. This temperature is due to heat build-up from the sun as well as the design of the lamp itself.

In addition, a change in temperature causes a change in the colour of light emitted by LEDs. The dominant wavelength of a LED will increase by one nanometre (1nm) for every 10°C rise in junction temperature.

This change in colour is not critical in brake light applications (where the allowable colour range of approximately 90nm is very broad) but in some amber signal lights the allowable colour range is much narrower at 5-10nm.

Apart from the actual power dissipation, the main factor in the temperature rise of the LED lamp is the way in which the LEDs are assembled and driven.

Table 1 shows various design layouts of LEDs in automotive lamps and their associated junction temperature rise (above ambient) versus power dissipation.

The layout indicated by line 2 of Table 1 is most commonly used in high-mount centre stop lamps and line 4 is most commonly used in rear combination (ie, turn/stop/tail) lamps. Table 1 indicates that if the LEDs are densely packed on the PC board, they will need to be derated; ie, operated at a reduced current.

The reduction of heat build-up within the lamp assembly can be accomplished in a number of ways.

Firstly, the PC board can have broad copper tracks on the cathode side of the LEDs, to act as heatsinks.

To reduce their heat contribution, the current limiting resistors can be mounted outside the lamp assembly, on a separate PC board or within the wiring loom.

If required, the current limiting resistors can be distributed evenly along the length of the PC board, to reduce the heat build-up at any one location.

In addition, the LEDs can be spaced as widely as possible and lamp housings ventilated by holes and/or the PC board thermally connected to the housing so it acts as a heatsink.

Mind you, in a typical Australian summer setting, the main source of temperature rise within the lamp housing will be the sun, so it won't be much of a heatsink – more a heat source!

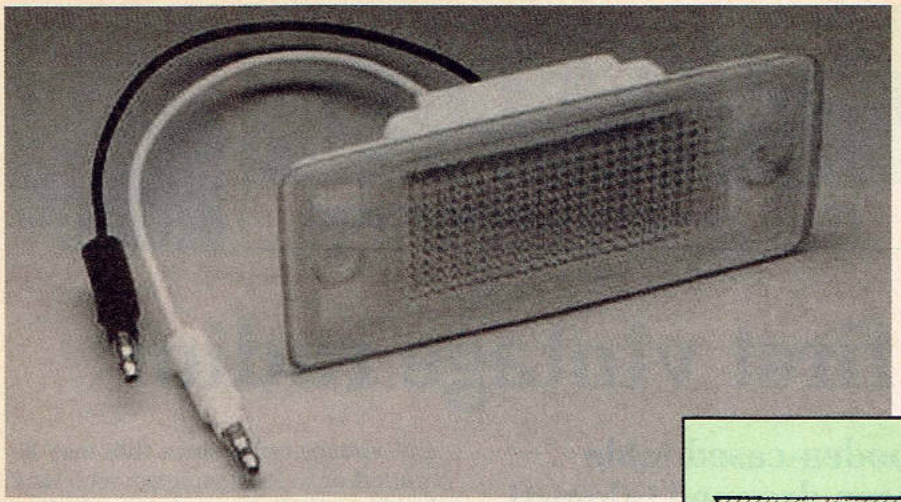
The electrical drive circuit can also be arranged to reduce LED heating.

Firstly, drive current fluctuations can be minimised and secondly, the drive circuit can be designed to dissipate the minimum amount of heat. Many drive circuits in LED high mount stop lamps consist only of a current limiting resistor and a silicon diode to prevent reverse-polarity connection.

This means that the LED current

	LED Lamp Design	Temperature Rise (°C/W)
1	Single row of LEDs with the current limiting resistors/drive circuitry located off PCB	325
2	Single row of LEDs with the current limiting resistors/ drive circuitry located on the same PCB as the LEDs	400
3	Multiple rows or an X-Y arrangement of LEDs with the current limiting resistors/drive circuitry located off the PCB	500
4	Multiple rows or an X-Y arrangement of LEDs with the current limiting resistors/drive circuitry located on the PCB	650

Table 1: the temperature characteristics of various combinations of LEDs used in automotive lamps. As LEDs are more densely packed on the PC board, or if the drive circuitry is included on the PC board, they need to be derated.



Marker lamps for trucks now commonly use amber LEDs. Turn indicator lights on cars will soon follow this lead. (Dialight).

varies with battery voltage. This is avoided by using a constant current drive circuit, as shown in Fig.4. Basically, this takes the form of an LM317 (or equivalent) adjustable voltage regulator connected as a constant current source.

Ambient temperature compensation can be used to allow the LEDs to be driven at a higher forward current during cooler conditions.

Note that this is the opposite approach to that discussed last month with regard to traffic lights, where an increase in temperature is accompanied by an increase in current so that adequate LED brightness is maintained.

Reducing the current at higher temperatures can be simply achieved by the use of a positive temperature coefficient (PTC) resistor. Fig.5 shows this approach.

Optical Design

Even more important than heat considerations is the design of reflectors and lenses.

The light distribution of a LED is symmetrical around its optical axis, as shown in Fig.6. However, unlike an incandescent lamp, a LED cannot be regarded as a point source of light.

Some of the light produced in a LED chip is refracted by the LED's epoxy dome (refracted-only light). The remainder of the light is reflected by the reflector cup and then subsequently refracted by the epoxy dome (reflected then refracted light).

Fig.7 shows this effect for a Super Flux LED.

The "refracted only" light appears to come from a certain location within the LED, while the "reflected-refracted" light appears to come from a different location. So the chip is not a point-source and light appears to come from a range of locations, termed the "focal smear".

In the HP Super Flux LEDs, the centre point of the focal smear is approximately 1mm below the base of the epoxy dome and this is used as an arbitrary point source for the purpose of the lens design.

The optics of a LED lamp can consist of a lens or reflector or a combination of both. The optics may spread the light (diverging optics) or gather the incoming light into a beam (collimating optics). The most common type of diverging optic used is the pillow lens, shown in Fig.8.

Collimating optics can use reflecting cavities in which the LEDs are mounted. These reflectors may have a straight or parabolic profile and are often used with a pillow lens, as shown in Fig.9. Another approach is to use a collimating lens such as a Fresnel design, shown in Fig.10. **SC**

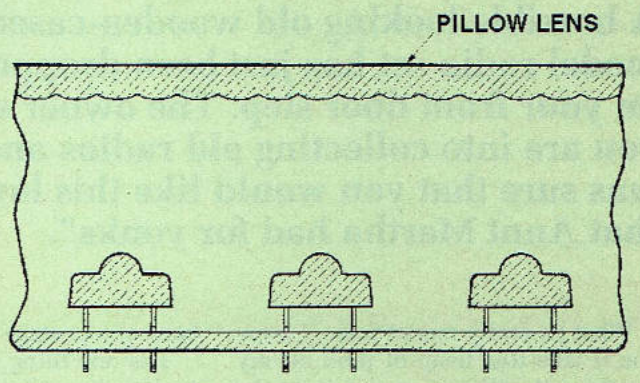


Fig.8: the pillow lens is commonly used in automotive LED lamps. It diverges the light from its source. (Hewlett Packard).

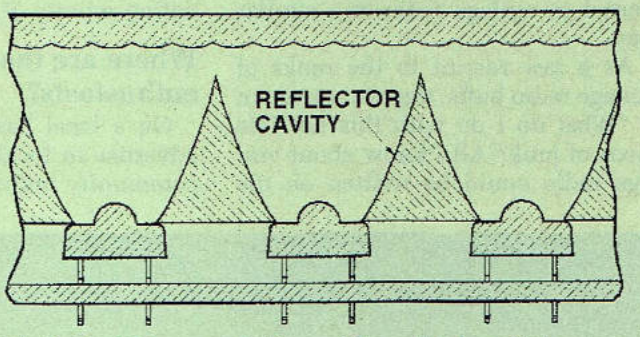


Fig.9: straight or parabolic profile multiple reflectors are often used in conjunction with a pillow lens. (Hewlett Packard).

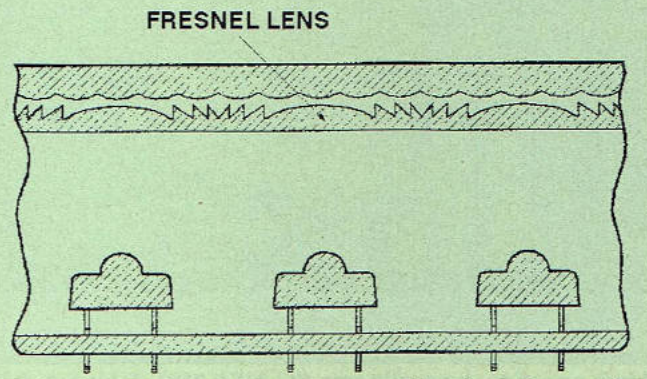


Fig.10: a LED luminaire using a combination of Fresnel and pillow lenses. (Hewlett Packard).

VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

Wow – my first vintage radio!

A horrible looking old wooden-cased table model radio set has just been dropped (almost) on your front door step. The owner says "I know you are into collecting old radios and things and was sure that you would like this lovely old set that Aunt Martha had for yonks".

What he really meant was, "I hope you'll take this heap of junk off my hands as it will save me a trip to the rubbish dump, and you'll think I'm a great bloke".

I wonder how many collectors started in vintage radio in a similar way.

As a raw recruit to the ranks of vintage radio buffs, the next question is "What do I do with this horrible piece of junk? All I know about vintage radio could be written on the back of a postage stamp!"

The one thing that you don't have to do is try and go it alone. There are several thousand enthusiasts in Australia and New Zealand who are quite eager to welcome you into the fascinating activity of vintage radio.

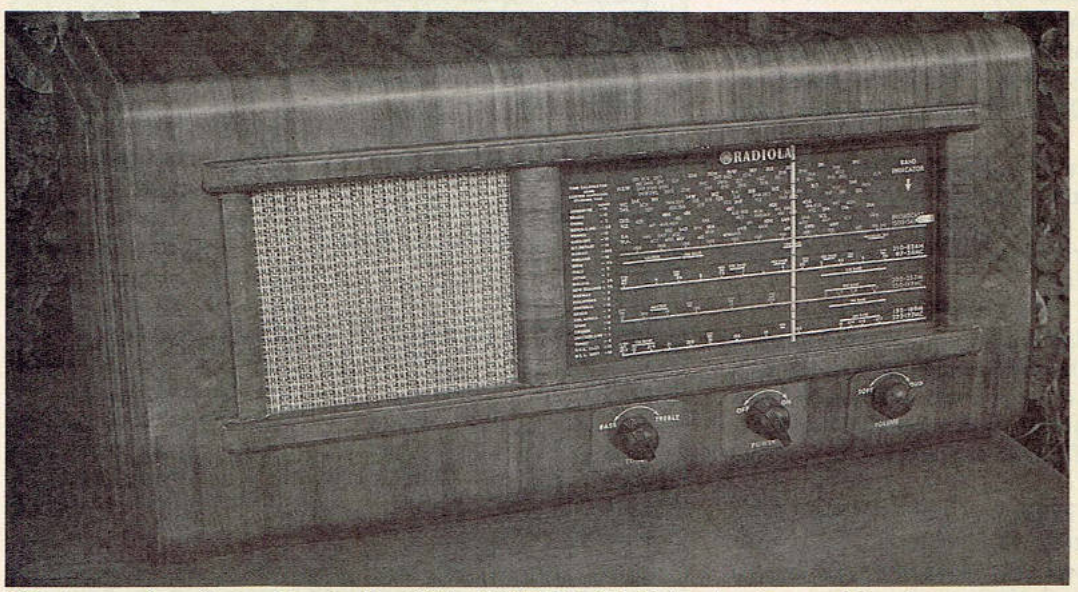
Where are the other enthusiasts?

On a local basis it is possible to advertise in local papers or on local community noticeboards concerning any vintage radio clubs that may be around or to find someone who may be able to help you restore your first vintage radio acquisition.

Enquiries at local electronics stores, the local antique dealers and second-hand dealers may also help you find like-minded restorers – probably ones with more experience than you possess, which is a decided bonus.

In New Zealand and Australia there are national vintage radio societies that cater for enthusiasts and in each case there is an enormous amount of information available through them. Their addresses are:

- Historical Radio Society of Australia Inc, PO Box 2283, Mt Waverley, Vic 3149. They have a quarterly publication entitled "Radio Waves" which contains lots of useful information.
- New Zealand Vintage Radio Society Inc, c/- G.W. Lindsey, 110 Sylvan Avenue, Northcote, Auckland 9, NZ



This is one of my favourite sets, the AWA 719T Table Set. It is a 6-valve model and covers seven bands. Sets as good as this one are worth every minute of a sometimes long and painful restoration!

Getting started

Having had this horrible old radio plonked on your door step, how do you physically go about making it into something that you could put on display?

The first point to consider is whether the set is actually worth restoration.

If the set is a model that is considered rare, valuable or highly sought after, it may be well worth restoring, even if it is in poor condition.

It may take quite some time to get parts or to make them, so don't rush the job. If it

is a common low-value set and not in good condition, it may not be worth restoring but it can form the start of a stockpile of useful parts for other sets. I have a whole shelf of sets that are not worth restoring which I use for spares.

If you have not been involved with restoration of vintage radios before, it would be a wise move to get an opinion on whether the set is worthwhile restoring.

As an example, there is no point in doing a lot of work on a chassis if the dial glass is broken and there is no hope of getting another, particularly if it is a multiband radio.

Fortunately there are some collectors reproducing dial glasses for a few sets.

Therefore, don't start cannibalising the set out if it is in otherwise good condition but keep it safely stored until such time as a dial glass can be obtained.

Swapping one set for another is another common activity amongst collectors, if the set you have is not one you really want.

Having decided that the set is worth keeping and restoring, there are several stages to the restoration project. An attractive cabinet is most desirable and most of the better timber mantel or console sets look really something once they have been cleaned, repaired (if need be) and polished.

If you are into fine woodwork you will be able to attend to this part with confidence. If not, a friend who is a woodworker can guide you, or hopefully a member of one of the clubs.

Initial cleaning

Even if you have little knowledge of cabinet work it is possible to clean the cabinets both inside and out. Plastic and Bakelite cabinets can be cleaned with soapy water.

It is necessary to remove all components such as dials, speakers and speaker cloth out of the cabinets, as they don't take kindly to dunking in water.

Make absolutely sure that any paper labels pasted inside the set don't get wet or they will disintegrate.

Wooden cabinets can be cleaned with a water-dampened cloth, or perhaps with a kerosene-dampened cloth to get some of the water insoluble gunk that accumulates off the cabinet. Do not use turps or other solvents as you will severely damage the finish. And make sure that you don't leave drops of water on the cabinet otherwise it will produce a white stain which is difficult if not impossible to remove.

The chassis of the radio can be cleaned by dusting it with a small paint brush, vacuuming it using a brush attachment and later, by using the blowing attachment on the vacuum cleaner.

Be particularly careful when cleaning around the tuning gang as grit and grime may lodge between the vanes and in the bearings. In fact, before you start cleaning the chassis, the first step should be to close the tuning gang vanes so that no physical damage occurs as you dust around the set.

Oh, and it's probably not a good idea to blow out the set with compressed air because you may actually force grit into places you don't want it, such as into the tuning gang, into the threads of coil slugs or perhaps even into the voice coil gap of the loudspeaker!

To clean the top of the metal chassis I use a Scotch-Brite scouring pad soaked in kerosene and by vigorously scrubbing it, I get most of the muck off. Later on, a rag soaked in kerosene will do a good job on the areas that are just mucky but not corroded.

The kerosene helps to protect a steel chassis so that it doesn't rust. It can be dried off after it is clean. Later on the chassis can be painted if need be.

Don't use steel wool to clean up a radio chassis. Inevitably you will get strands of steel wool lodged in the circuit where it can cause short circuits.

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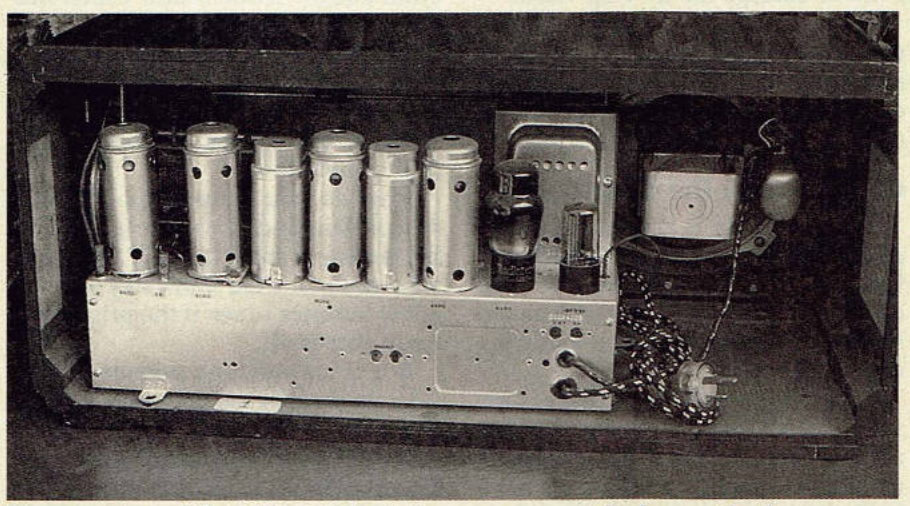
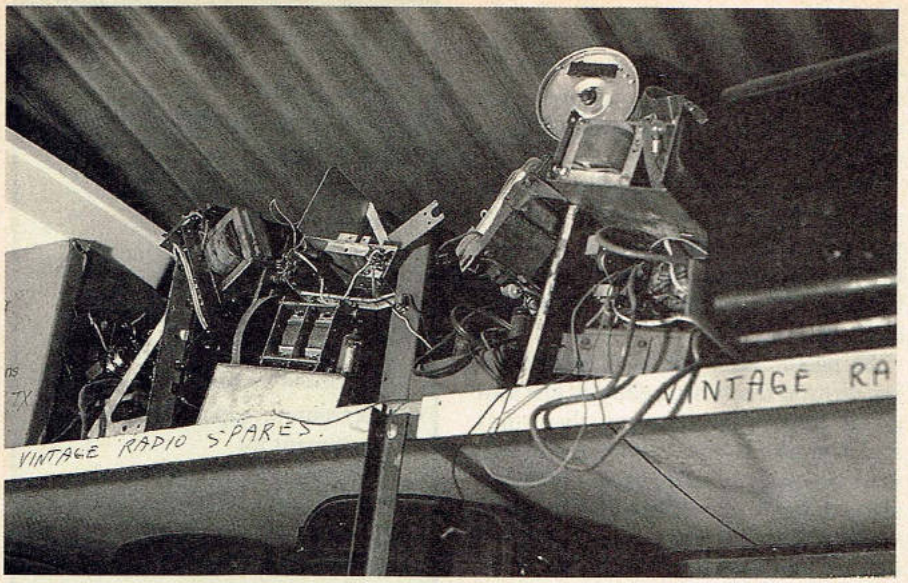
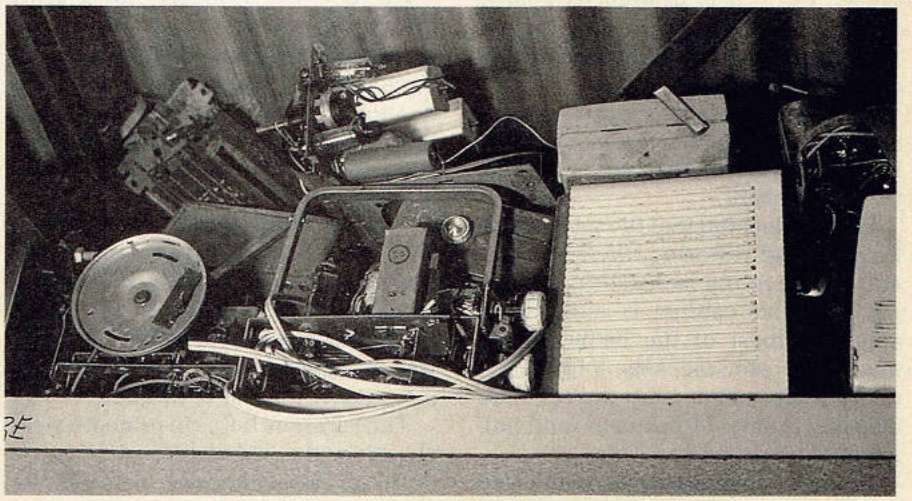
Treating the underside

Having cleaned the top of the chassis, a look underneath will usually reveal that it is relatively clean, unless it has been stored upside down or mice have made a nest in it. Radios that mice have invaded often have



The rear view of the AWA 719T set. As you can see, it looks exactly the same as the day it came out of the factory. Sometimes, though, you have to camouflage new components into old cases when the original isn't available any more.





(Left and below): I have several shelves just like these, filled with bits and pieces of old radios and in some cases complete radios that aren't worth repairing. But they are a very handy source of old, hard-to-get (and sometimes impossible-to-get) parts. Surplus sets and components can also be swapped or traded for that particular bit you *really* need!

considerable damage – and they smell. Having cleaned out as much muck as possible, spray the switch contacts, valves socket pins, etc, with one of the contact cleaning aerosol sprays. While not being ideal for this task, CRC2-26 and WD40 can do quite a reasonable job.

Another big caution concerns the tuning gang. DO NOT spray the tuning gang with these products. They might clean them initially but the residue tends to attract dust and it can be partially conductive and may even upset the tuning, due to a change in the dielectric constant of the gang.

If you really must clean the tuning gang vanes, gently brush some methylated spirits on the gang and blow the lot out with your vacuum cleaner, taking care that the airflow doesn't bend or damage the moving vanes.

All control shafts, pulleys and slides should be lightly oiled to get them operating smoothly, as over a period of years they often seize up due to corrosion and lack of lubrication.

Caution with the dial scale

The dial scale is a very important part of the set; without it or with one that's badly discoloured or otherwise damaged, the set won't be worth much. Note that the actual station markings don't mean a lot.

Sure it's nice to have all those interstate stations marked on the dial but remember that some of those stations no longer operate or they may have shifted in frequency with the adoption of 9kHz spacing about 17 years ago.

Even if the dial-scale is intact, it may need cleaning. The outside can be quite easily cleaned with a wet cloth but the reverse side which has the station call signs screen-printed on it can only be cleaned with great care.

In many cases it just isn't possible to wash the dirt off as the printing will come off too.

How do you know if the printing will be damaged by washing? Answer: by testing a small part of the print with water. Let the water stay on it for a few minutes to see if the print stays on or comes off.

If it comes off, you may be able to remove most of the dirt with a small dry paint brush. Again, don't brush too heavily or it may still damage the printing. In some cases it may not be possible to clean the printed side of dial glass at all. However, many are quite OK and can be washed in water and the print will stay on.

But, I must repeat the caution about being careful about cleaning the dial glass; the print may disappear before your eyes.

I've been caught out on this myself and have a ruined dial glass. I could have cried and there was no replacement available.

Having cleaned the chassis and cabinet, and particularly if they were in good order to start with, you now have quite a good static display restored set. Some people only go this far and don't concern themselves with actually making the set go.

However, a completely restored working set is an even more valuable asset. I like observing how well some of the vintage radios perform; often they are a lot better than many transistor radios.

Full restoration

The next step is where many new restorers make a big mistake. What they do is to plug the set into power, whether with batteries or mains, and turn the set on.

Usually the set you are restoring has been sitting in some damp, dirty location for many years. Mice may have had made a home in the set and

it was probably put out there in the first place because it had stopped working.

For all of these reasons it is most unwise to apply power to any set which has not been checked out thoroughly.

In many cases, the set can have very serious and sometimes dangerous faults and if power is applied you can cause serious damage which could be irreparable. Having come this far, that would be sad.

If you don't have any experience, don't even think about connecting the set to the mains power. Instead, enlist the aid of someone familiar with valve sets to get the set operating.

Alternatively, you might consider having the set professionally restored. Even if it costs quite a few dollars, in some cases it will be worthwhile.

Almost always I overhaul the electronics of a set before I am prepared to turn it on, whether it's mine or one that I am restoring for someone else.

Don't forget that this column has been going since June 1988 so there is a huge amount on this subject in the back issues of SILICON CHIP and I will be going over some of the key material in future issues.

Where to buy parts

Surprisingly, parts for later model valve radios are not all that hard to obtain but valves for some of the very early sets made in the 1920s may not be available at all.

Paper capacitors (condensers) are no longer available and most restorers will say thank goodness for that, as they are usually defective. They are usually replaced with polyester capacitors which are much smaller and look quite different.

Some restorers don't like to see new style components in sets and will even bore out the insides of the old paper capacitors and install the smaller polyester units inside.

With many old paper capacitors, particularly those encapsulated with pitch, this just won't be possible though, as they will disintegrate.

Quite often substitute components will have to be used if the set is to function properly, as having some components like interstage audio transformers and power transformers rewound is an expensive exercise. In many cases these substitutes can be disguised within the case of the original component, as in the example of the paper capacitors.

Any old radio that you come across can be a source of components either now or later on, so don't throw any old sets out until you've been able to remove all of the useful bits. These might be the valves, valve sockets, transformers, radio frequency and intermediate frequency coils/transformers, switches, cabinets, speakers, knobs, tagstrips, dial scales, tuning capacitors and so on.

The following sources will often prove valuable in your search for sets to add to your collection and for spares: garage sales, antique/second-hand dealers and advertisements in local papers.

The local rubbish tip can be a useful source too if you are allowed to scavenge.

What are you interested in restoring?

Having restored your first set, you may want to continue collecting and restoring radios of the same general type.

Or you may find that your particular interest is in another direction. Some collectors and restorers like to concentrate on a particular era or particular types of radio.

For example, some concentrate on collecting and building crystal sets, while others may be interested in high-performance multi-valve, multi-band receivers. Some are interested in the 1920s era while others are into transistor radios.

Initially, I grabbed anything that I could lay my hands on that didn't cost me an arm and a leg to obtain. As my collection grew I became more selective in what I obtained as I was starting to run out of room.

Collections vary from just one or two sets up to over 500 radios, which I saw in one collection recently. My collection is rather modest in comparison.

The photographs in this article are of one of my favourite restored receivers, plus a number of wrecked sets not worth restoring. They are waiting to be cannibalised to finish off the restoration of other sets.

Good luck with your venture into vintage radio, I'm sure you will enjoy the challenge and the end results. Our radio heritage is a valuable part of our social and technical history. SC

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By JOHN CLARKE

Don't blow your engine – fit this rev limiter

Do you regularly rev your engine to the red line on your car's tacho? Have you ever missed a gear change and spun the engine to squillions of revs? Or have you actually blown your engine by over-revving it? If so, you need this rev limiter. It can save thousands of dollars damage to your engine.

This versatile rev limiter works by blocking some of the ignition sparks when the engine exceeds the preset limit. It is not a "hard" limiter which kills the engine RPM by stopping fuel and all the sparks from the ignition system. Instead, it blocks about 50% of the sparks once you exceed the preset rev limit. So instead of suddenly "running into a wall" your engine runs out of puff" and it won't be damaged.

The rev limiter incorporates three indicator lamps, two (green) to indicate that you're approaching the RPM limit and the third (red) to indicate

Features

- Limits engine RPM by ignition spark reduction
- Uses Hall Effect, points, low voltage signal or reluctor input or ignition coil to measure RPM
- Adjustable limit for RPM restriction
- Two prelimiting warning indicators
- One limit warning indicator
- Can be used as a gear change indicator
- Single component selection to suit most engines

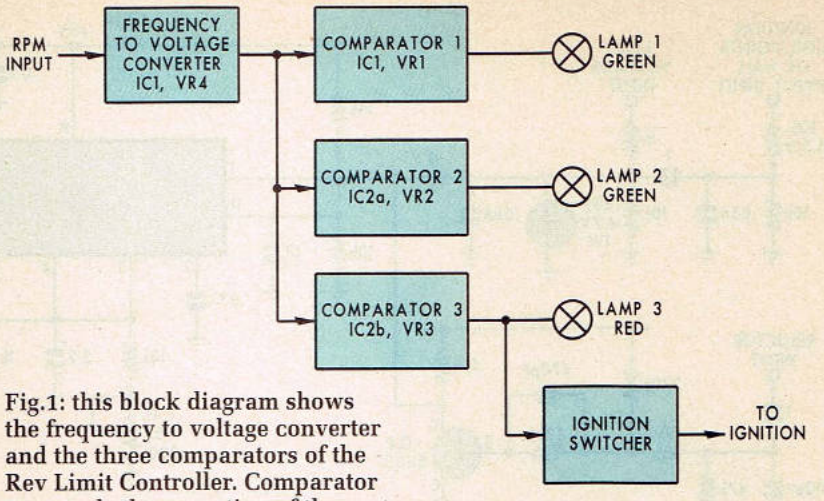


Fig.1: this block diagram shows the frequency to voltage converter and the three comparators of the Rev Limit Controller. Comparator 3 controls the operation of the Ignition Switcher board.

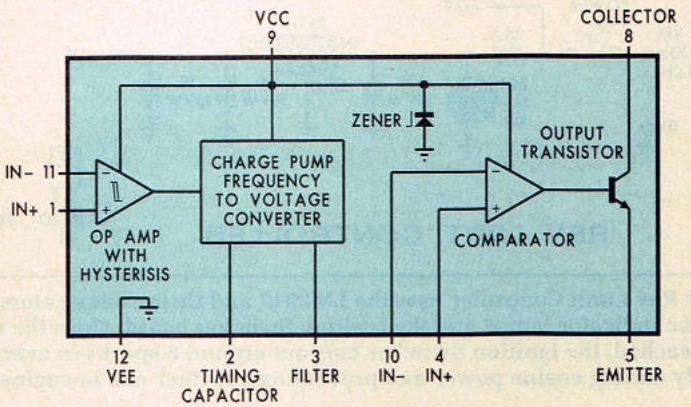


Fig.2: the LM2917 frequency-to-voltage converter monitors the spark rate as a measure of engine RPM.

that "rev limiting" is occurring.

As an alternative use, this project could be employed as a simple gear change indicator, with or without the bonus of rev limiting.

If you have a performance engine in your car and it has a typical 5-speed manual gearbox, you already know how easy it is to spin the engine out to and beyond its red line on the tacho. The red line is not an arbitrary limit but is based on a judgment made by the car manufacturer about risk of damage to your engine.

Provided you drive below the red line, your engine should have a long life, all other things being equal. But exceed that limit and you risk doing serious damage and even catastrophic failure, such as putting a con rod through the side of the block.

The risk of damage to your engine is much greater if you exceed the red line when the engine is unloaded, as it is if you happen to miss a gear change when accelerating strongly. So if your car is capable of high performance and you are keen to push it to the limit at every opportunity, then you really do need a rev limiter.

Of course, some modern cars already have very effective rev limiters built into their engine management systems but the majority of cars do not have this very worthwhile protection.

The Rev Limiter comes in two parts. The Rev Limit Controller is housed in a small plastic instrument case which can be mounted on your car's dash panel. It has three lights on the front panel and an on/off switch. Four trimpot adjustments set the sensitivity and the RPM thresholds for the three indicator lamps and the rev limit itself. The Rev Limit Controller operates the Ignition Switcher which is a modified version of the Engine Immobiliser circuit which was published in the December 1998 issue of SILICON CHIP.

The Ignition Switcher operates by shorting out the engine's ignition coil switching transistor (or the ignition points) about 50% of the time. This severely restricts engine power and hence limits the RPM. The Rev Limit Controller monitors engine RPM and is connected to the ignition trigger system which can be Hall effect pickup, reluctor pickup or a low voltage signal from the engine management computer to the ignition switching transistor.

If you have a conventional points ignition (ie, Kettering not transistor-assisted or CDI), there is a bit of a problem. The engine speed monitoring will take place at the same point as the ignition blocking action and therefore the rev limiting action may be inconsistent and will tend to give quite rough engine operation when limiting is occurring. Mind you, we assume that there will not be too many performance engines which don't have some sort of high energy ignition system.

Block diagram

Fig.1 shows the block diagram, em-

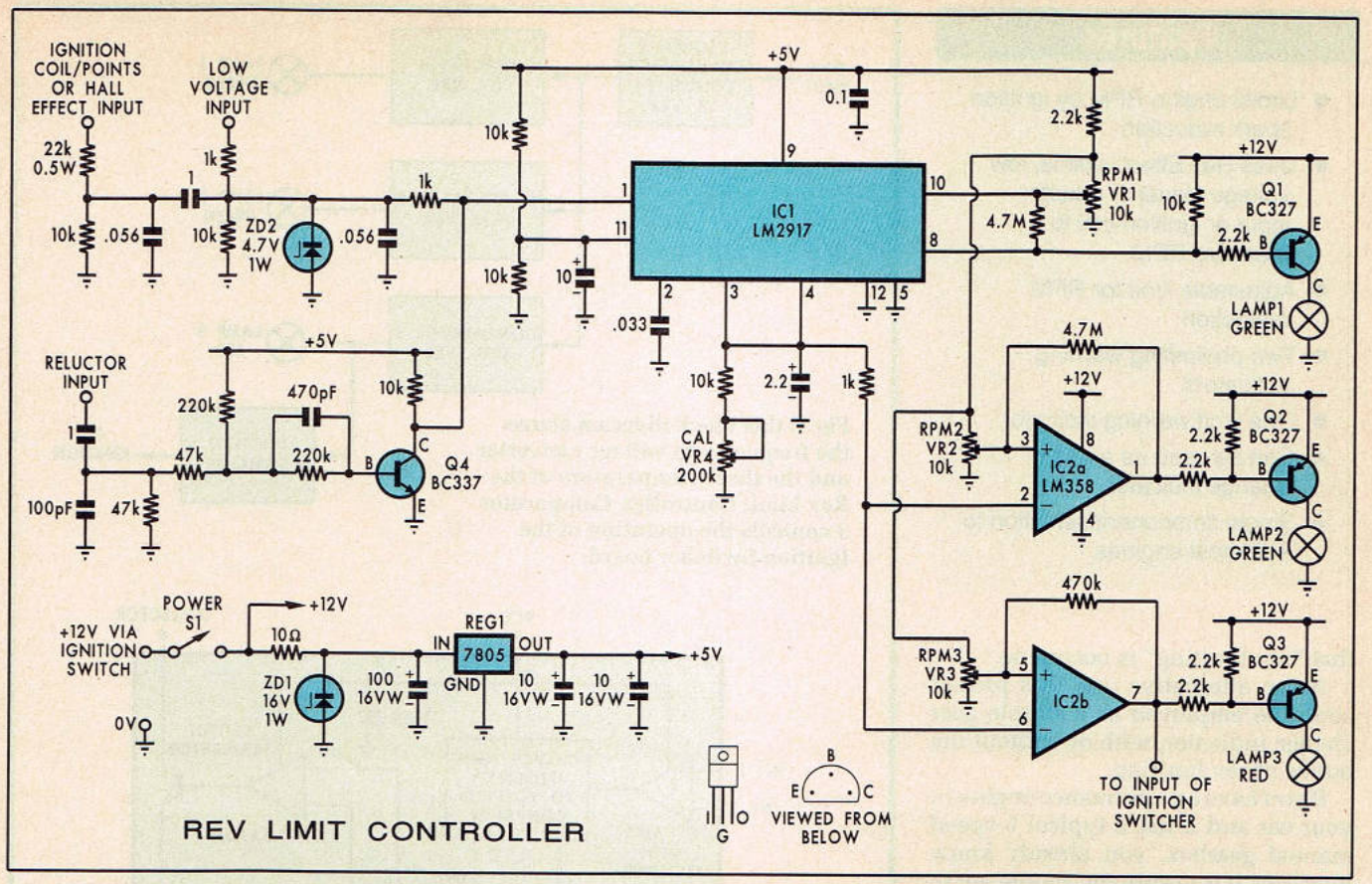


Fig.3: the Rev Limit Controller uses the LM2917 and three comparators to control the indicator lamps and the Ignition Switcher board. Once the red-line limit is reached, the Ignition Switcher cuts out around 8 sparks in every 16, effectively cutting engine power and preventing a further rise in engine speed.

bracing both parts of the Rev Limiter. The signal from the ignition pickup is processed in a frequency-to-voltage converter which produces a DC voltage which is proportional to the input frequency. The frequency-to-voltage converter is the well-proven LM2917 and its block diagram is shown in Fig.2.

The output from the frequency-to-voltage converter is fed to three comparators, one of them inside IC1. Two of the comparators drive warning lamps to warn the driver of the onset of rev limiting while the third comparator actually controls the Ignition Switcher board.

The Ignition Switcher must be set so that it only blocks out a nominal 8 sparks in every 16. It switches on at a rate which is fast enough to reduce engine power but not produce any noticeable jerking in the engine which would be the case if it switched at a lower rate.

The setting to switch out 8 sparks in 16 (a duty cycle of 50%) is fairly critical. If more sparks are switched out, there is a higher risk of backfire, while less sparks cut out will mean less power reduction and rev limiting will be less effective.

Circuit description

Fig.3 shows the circuit for the Rev Limit Controller while Fig.4 shows the circuit for the Ignition Switcher.

Fig.3 comprises two ICs and a regulator plus several transistors and passive components. There are two input circuits, one for a reluctor pickup and the other for the remaining types of engine ignition triggers. Only one of these should be used at any time.

The signal from the ignition points or Hall effect input is fed to a voltage divider comprising 22kΩ and 10kΩ resistors bypassed by a .056μF capacitor. The signal is then AC-coupled via a 1μF capacitor to a 10kΩ resistor and a 4.7V zener diode to provide signal clamping. The 1kΩ input resistor is there to provide a low voltage signal input point such as the 5V signal from an engine management computer. Further filtering is provided at this point using another .056μF capacitor before the signal is applied via a 1kΩ resistor to pin 1 of IC1.

The reluctor input uses a 1μF coupling capacitor to provide isolation from the trigger circuit used on the engine ignition while a 100pF capacitor filters out any high-frequency hash. The signal is then applied to the base of transistor Q4 via 47kΩ and 220kΩ resistors and a 470pF speed-up capacitor. The collector of Q4 is normally low and a negative-going reluctor signal switches off Q4 which then has its collector pulled high via the 10kΩ resistor. This signal is applied to pin 1 of IC1.

Following the op amp comparator within IC1 is a charge pump. This basically switches charge from the .033μF capacitor at pin 2 to the 2.2μF capacitor connected to pins 3 & 4. This occurs on each comparator detection of a signal on pin 1. The 10kΩ resistor and trimpot VR4 at pin 3 discharge the 2.2μF capacitor to provide a time constant for the charge pump circuit. VR4 provides the calibration adjustment for the circuit.

A second comparator within IC1

monitors the voltage at pins 3 & 4. The inverting input of this internal comparator (pin 10) connects to trimpot VR1 which sets the threshold voltage. The comparator output (pin 8) is an open-collector transistor and this output drives transistor Q1. When pin 3 of IC1 goes above pin 10, pin 8 goes low and this turns on transistor Q1 and Lamp 1 then lights up.

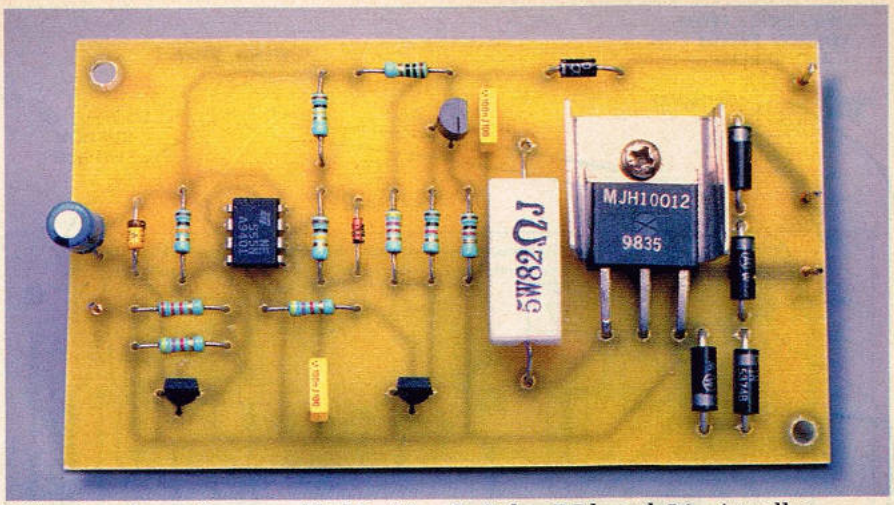
Comparators IC2a & IC2b also monitor the pin 3 output of IC1. IC2a's output goes low when its pin 2 goes higher than the preset voltage from trimpot VR2 at pin 3. When this happens, transistor Q2 turns on and this lights Lamp 2.

IC2b operates in a similar manner to IC2a and has a threshold set by trimpot VR3. It drives Q3 which lights Lamp 3 and it also goes low to drive the Ignition Switcher circuit shown in Fig.4.

Power for the circuit comes from the car's ignition switch, switch S1 and a 10Ω resistor to a 16V zener diode which provides protection from any spike voltages. From there it goes to a 3-terminal regulator REG1 which provides a 5V supply for IC1. IC2, the transistors and the Lamps run from the +12V rail.

Ignition switcher

As noted above, the Ignition Switcher circuit in Fig.4 is an adaptation of the Engine Immobiliser circuit which appeared in the December 1998 issue of SILICON CHIP. This circuit uses a single 555 timer IC and four transistors.



This view shows the assembled Ignition Switcher PC board. It's virtually identical to the Engine Immobiliser circuit published in the December 1998 issue of SILICON CHIP.

Q1 is a high-voltage Darlington transistor designed for ignition systems. It can switch the heavy coil current and can withstand the voltages that are produced across the coil (typically around 250V peak) when the engine is running normally. The four 75V zener diodes between the collector and emitter of Q1 prevent voltages over 300V from damaging the device.

Normally, the Ignition Switcher circuit is quiescent (ie, not active) and transistor Q1 is off. The circuit is activated by a low signal from the Rev Limit Controller and this turns transistor Q4 off.

When this happens, 555 timer (IC1) is able to oscillate, at a frequency determined by the two 100kΩ resistors and capacitor C1, connected to pins 2, 6 & 7.

The resultant waveform at pin 3 is a square wave. Each time pin 3 goes high it turns on Q3 and this turns on Q2 and Q1. Each time Q1 turns on, it effectively shorts out the ignition points or the main ignition coil driver transistor (in a transistorised ignition system). And each time this happens, no sparks are delivered to the engine.

Spark switching rate

C1 must be selected to suit the rev limit for your engine. To do this, you

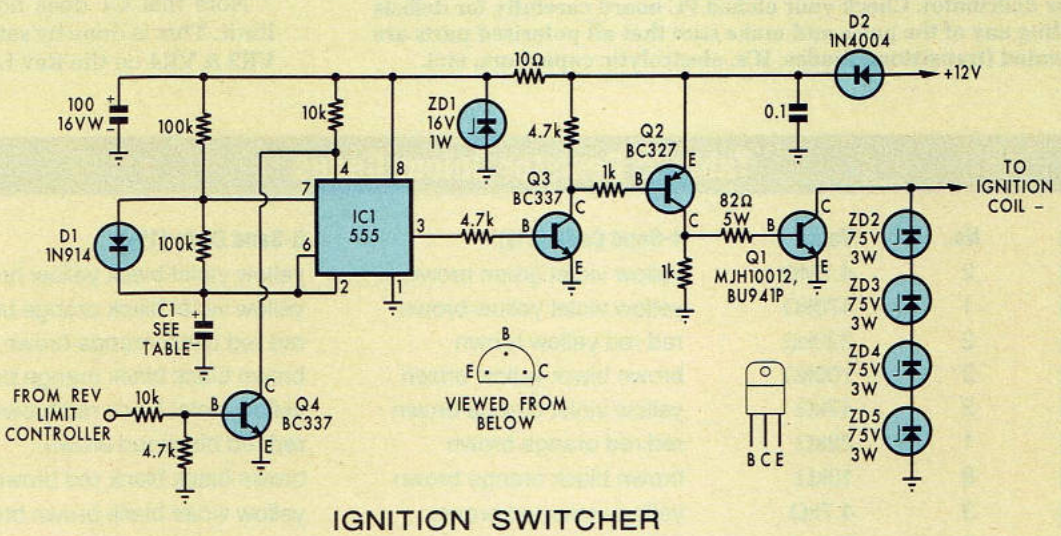


Fig.4: based on our previous Engine Immobiliser circuit, the Ignition Switcher shorts out the main switching transistor in the car's ignition system, effectively removing 8 out of every 16 sparks, once the red-line limit is reached.

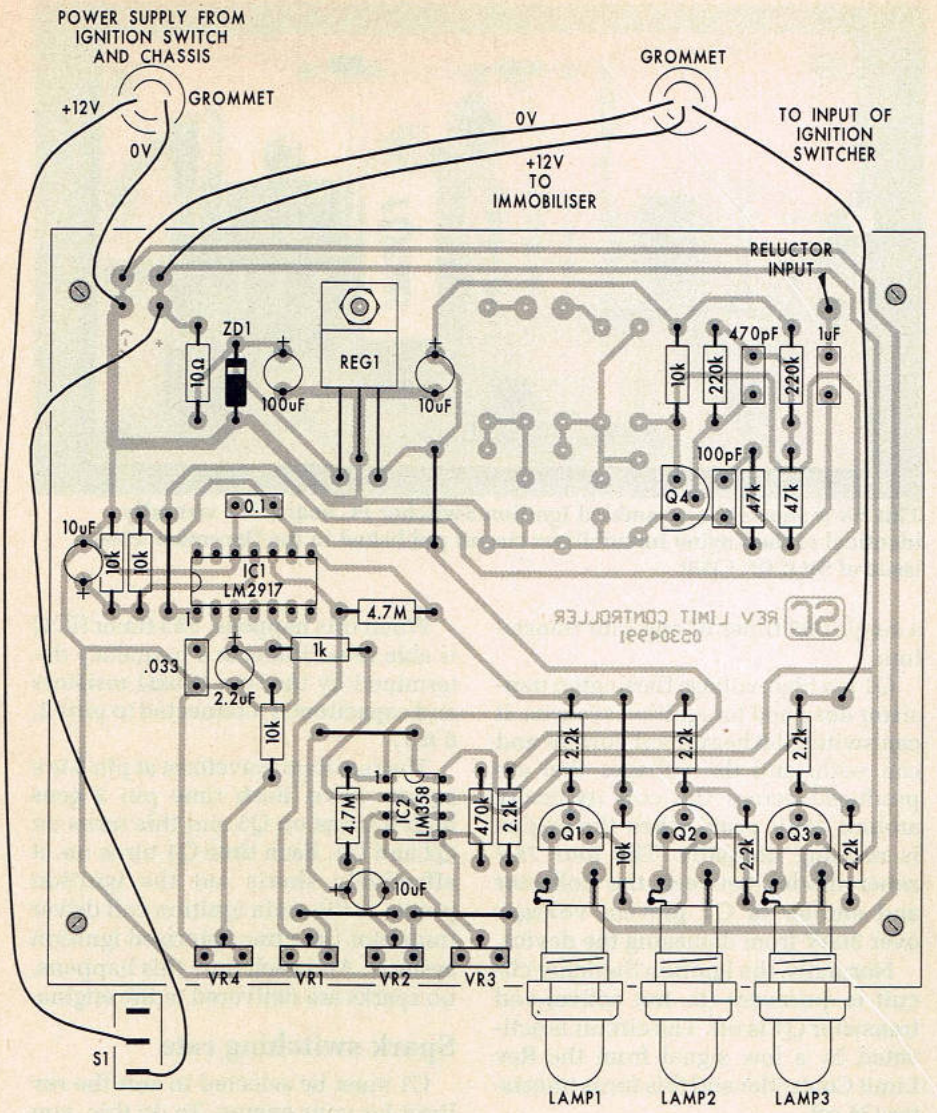


Fig.5: use this component layout for the Rev Limit Controller circuit if your car has a reluctor distributor. Check your etched PC board carefully for defects before installing any of the parts and make sure that all polarised parts are correctly oriented (transistors, diodes, ICs, electrolytic capacitors, etc).

Table 1: Choosing C1

Spark Rate	C1
up to 250sp/s	0.47µF
250 to 300sp/s	0.39µF
300 to 350sp/s	0.33µF
350 to 420sp/s	0.27µF
420 to 500sp/s	0.22µF
500 to 600sp/s	0.18µF

must do a simple calculation, as follows:

Spark rate = revs x sparks/rev ÷ 60.

The figure for revs is the red-line limit for your car's engine. The figure for sparks/rev is the number of firing strokes per revolution of your engine. For example, a 4-cylinder (4-stroke) engine has two firing strokes/revolution, a 6-cylinder has three firing strokes/revolution and a V8 has four firing strokes/revolution.

You multiply these two figures and divide by 60 to get a result in sparks per second. For example, if you have a 6-cylinder engine with a 6000 RPM red-line limit, multiplying 3 by 6000 and dividing by 60 gives a result of 300 sparks/second. If you have a 4-cylinder with a 8000 RPM limit, the result is 267 sparks/second and for a V8 with a 5000 RPM limit, the result is 333 sparks per second. This should give you the picture.

The value for C1 can then be chosen from Table 1.

Note that C1 does not set the rev limit. This is done by setting trimpots VR3 & VR4 on the Rev Limit Control-

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	4.7MΩ	yellow violet green brown	yellow violet black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	2	220kΩ	red red yellow brown	red red black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	8	10kΩ	brown black orange brown	brown black black red brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	6	2.2kΩ	red red red brown	red red black brown brown
❑	5	1kΩ	brown black red brown	brown black black brown brown
❑	2	10Ω	brown black black brown	brown black black gold brown

Table 3: Capacitor Codes

Value	IEC Code	EIA Code
1µF	1u	105
0.1µF	100n	104
.056µF	56n	563
.033µF	33n	333
470pF	471	470
100pF	101	100

ler. C1 merely sets the number of sparks which are blocked out during the limiting action at the specified RPM.

Power for the Ignition Switcher is taken from switch S1 in the Rev Limiter circuit. Diode D2 isolates the circuit and a 0.1µF capacitor decouples the supply to transistors Q2 & Q3. IC1 is protected from voltage transients by the 10Ω resistor in series with the supply and the 16V zener diode ZD1. The 100µF capacitor decouples the supply rails.

Construction

The Rev Limit Controller is built on a PC board measuring 117 x 102 mm and coded 05304991. This board fits into a plastic case measuring 140 x 111 x 35mm and we have designed a label measuring 133 x 27mm for the front panel.

The Ignition Switcher is built onto a PC board measuring 106 x 60mm and coded 05412981. This board can be fitted into a small plastic case measuring 82 x 53 x 30mm or merely fitted with a sleeve of heatshrink tubing.

Fig.5 shows how the Rev Limit Controller board is wired for a distributor with reluctor pickup. Fig.6 shows how it should be wired if you have Hall Effect, points input or low voltage signal from an engine management computer. Make sure you use the correct overlay diagram when assembling this PC board. Fig.7 shows the component overlay for the Ignition Switcher board and remember that you need to consult Table 1 to pick the value for C1.

You can begin construction by checking the PC boards for shorts between tracks and possible breaks and undrilled holes. Fix any problems before inserting any components. Then insert and solder all the links as shown on the overlay diagrams.

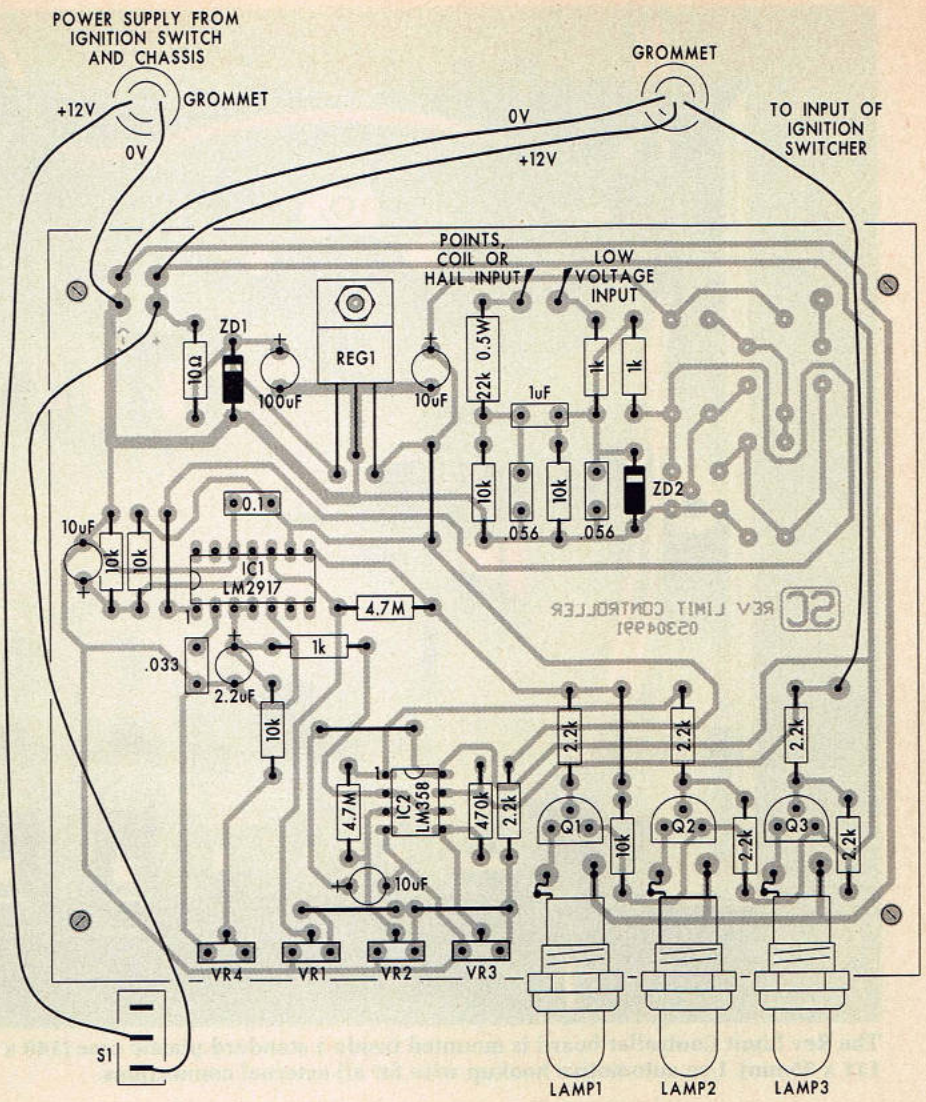


Fig.6: if your car has does not have a reluctor distributor (ie, uses points, Hall Effect pickup, etc) use this layout to wire up the Rev Limit Controller. Lamps 1 & 2 should be green, while Lamp 3 is red.

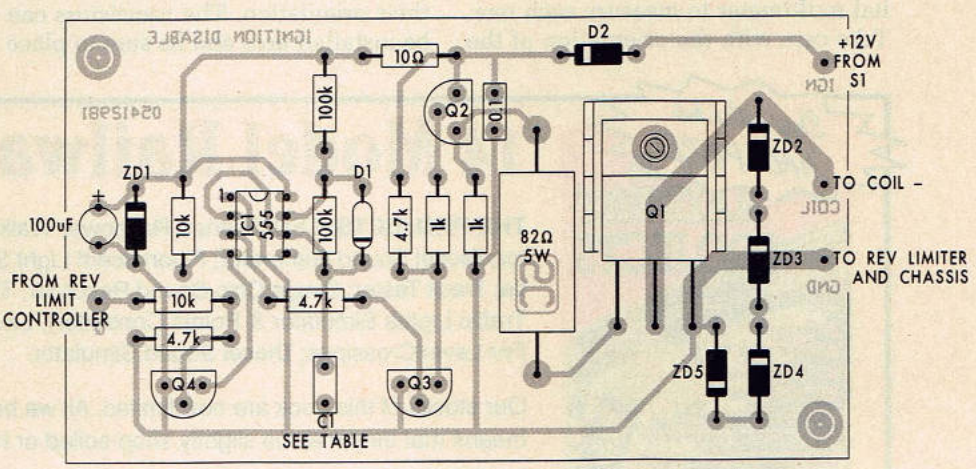
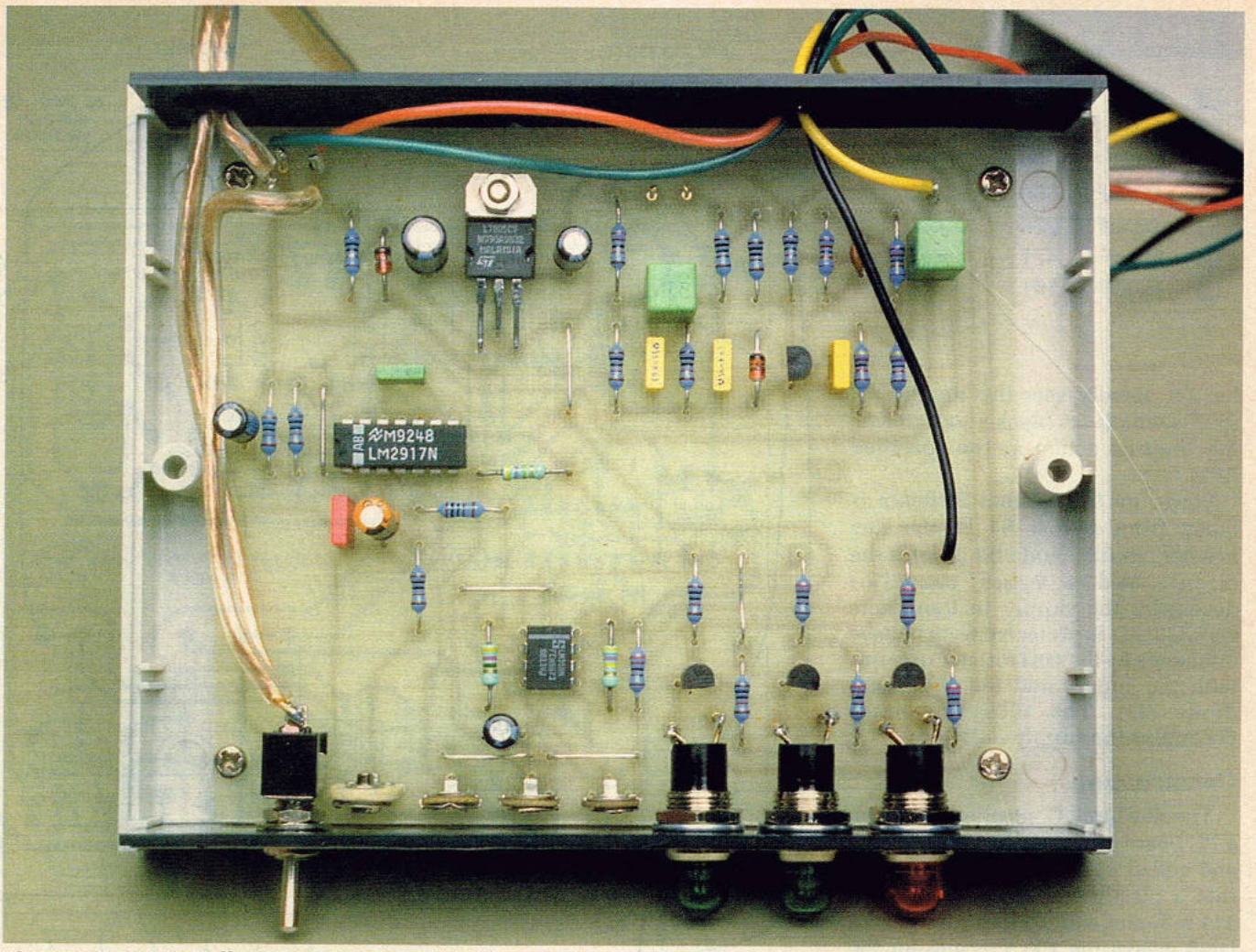


Fig.7: this is the layout for the Ignition Switcher board. Note that the zener diodes (ZD1-ZD5) must all be oriented correctly, otherwise the circuit won't work. In particular, note that ZD5 faces in the opposite direction to ZD4. The assembled board should be enclosed in a plastic case or heatshrink tubing and mounted under the dashboard.

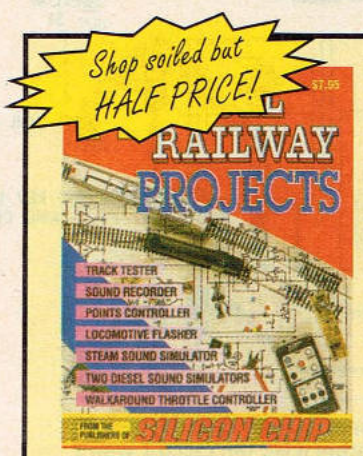


The Rev Limit Controller board is mounted inside a standard plastic case (140 x 111 x 35mm). Use automotive hookup wire for all external connections.

Insert and solder in the resistors, using Table 2 as guide to the resistor colour codes. You can also use a digital multimeter to measure each one. Take care with the orientation of the ICs when you are installing them.

Next, solder in all the diodes, including the zeners, and take care with their orientation. The transistors can be installed next and be sure to place the correct type in each position. Then insert the capacitors and note that the electrolytic capacitors must have the correct polarity. Table 3 shows the codes which will be shown on the MKT types.

REG1 is mounted horizontally, with its metal face towards the PC board.



14 Model Railway Projects

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Bend the leads to insert them into the holes allocated before securing the regulator with a screw and nut. Similarly, transistor Q1 on the Ignition Switcher PC board is mounted horizontally and with a heatsink sandwiched between the device and the PC board. Use a screw and nut to secure this assembly in place.

Finally, insert the PC stakes and trimpots.

Case

The front panel of the case requires holes for trimpot access, power switch S1 and the indicator lamps. Use the front panel label as a guide to the positioning of the holes. You will also need to drill the holes in the rear panel for the grommets. Fit the front panel label in position and cut the holes out with a sharp hobby knife. The Rev Limit Controller board and front panel can be placed in the case and secured with four self-tapping screws into the integral standoffs in the base of the case.

Attach S1 and the lamp bezels in position and connect hookup wire from the +12V and GND terminals on the main PC board and pass these through the grommet. Similarly connect up wires to the reluctor or coil or low voltage input which are required to connect to the ignition trigger output on the engine and to the input of the Ignition Switcher.

Complete the wiring to switch S1 and to the lamp terminals.

Testing

Starting with the Rev Limit Controller, apply 12V between the +12V and GND terminals on the main PC board. This done, check that the output of regulator REG1 is at +5V.

You will now need to apply some voltage to pins 3 of IC1 using a 10kΩ resistor between this pin and the 5V supply. Now adjust VR1 and check that the light comes on. Similarly, check Lamp 2 with VR2 and Lamp 3 with VR3. Check that pin 7 of IC2b goes low when Lamp 3 is lit.

Note that you can check operation using a signal generator. Apply signal to the points input or reluctor terminal and adjust the output frequency to monitor operation of the lamps.

Installation

The Rev Limit Controller can be installed into the vehicle using automotive connectors to make the connection to the +12V ignition supply. Use automotive wire for this connection. The ground connection can be made to the chassis with an eyelet and self-tapping screw.

Attach the case in a position convenient to the driver and secure it with suitable brackets. This done, connect up the signal input from either the points, Hall effect, low voltage or reluctor outputs. Now start the engine and set VR4 to its mid-setting.

To adjust the three trimpots (ie, VR1, VR2 and VR3), the engine should be under load. In practice, this means

Parts List

Rev Limit Controller

1 PC board, code 05304991, 117 x 102mm
1 plastic case, 140 x 111 x 35mm
1 front panel label, 133 x 27mm
1 SPDT toggle switch (S1)
2 green 12V indicator lamps and bezels (Lamp 1, Lamp 2)
1 red 12V indicator lamp and bezel (Lamp 3)
1 M3 screw and nut
4 self-tapping screws
2 small rubber grommets
1 100mm length of 0.8mm tinned copper wire
1 1m length of twin figure-8 medium duty wire
1 1m length of red medium duty hookup wire
1 1m length of black medium duty hookup wire
1 1m length of green medium duty hookup wire
1 1m length of yellow medium duty hookup wire
14 PC stakes
3 10kΩ vertical trimpots (VR1-VR3)
1 200kΩ vertical trimpot (VR4)

Semiconductors

1 LM2917 frequency-to-voltage converter (IC1)
1 LM358 dual op amp (IC2)
1 7805 5V 3-terminal regulator (REG1)
3 BC327 PNP transistors (Q1-Q3)
1 BC337 NPN transistor (Q4)
1 16V 1W zener diode (ZD1)
1 4.7V 1W zener diode (ZD2)

Capacitors

1 100µF 16VW PC electrolytic
3 10µF 16VW PC electrolytic
1 2.2µF 16VW PC electrolytic
1 1µF MKT polyester
1 0.1µF MKT polyester
2 .056µF MKT polyester
1 .033µF MKT polyester
1 470pF ceramic
1 100pF ceramic

Resistors (0.25W, 1%)

2 4.7MΩ	6 10kΩ
1 470kΩ	6 2.2kΩ
2 220kΩ	3 1kΩ
2 47kΩ	1 10Ω
1 22kΩ 0.5W	

Miscellaneous

Hookup wire, solder, etc.

Ignition Switcher

1 PC board, code 05412981, 106 x 60mm
4 PC stakes
1 mini heatsink 19 x 19 x 9.5mm
1 M3 x 9mm screw
1 M3 nut

Semiconductors

1 555 timer (IC1)
1 MJH10012, BU941P power Darlington transistor (Q1)
1 BC327 PNP transistor (Q2)
2 BC337 NPN transistors (Q3, Q4)
1 16V 1W zener diode (ZD1)
4 75V 3W zener diodes (ZD2-ZD5)
1 1N4148, 1N914 signal diode (D1)
1 1N4004 1A diode (D2)

Capacitors

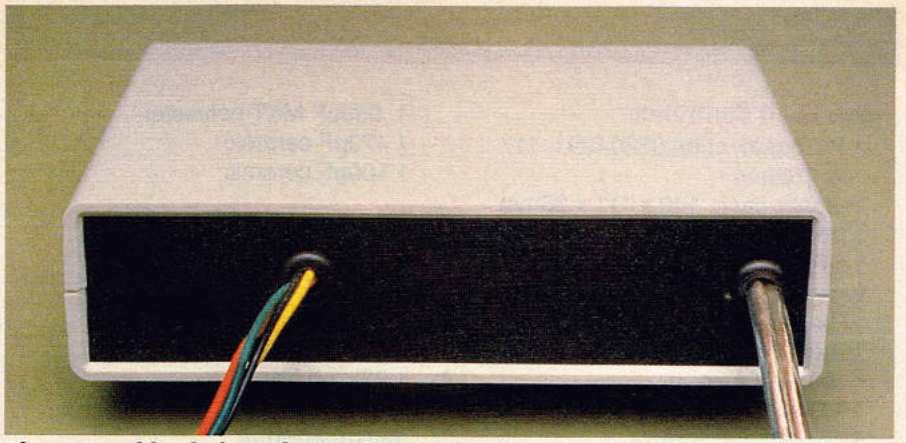
1 100µF 16VW PC electrolytic
1 0.1µF MKT polyester
1 C1 (see text)

Resistors (0.25W, 1%)

2 100kΩ	2 1kΩ
2 10kΩ	1 82Ω 5W
3 4.7kΩ	1 10Ω

Miscellaneous

Automotive wire, automotive connectors, solder, etc.



The external leads from the Rev limit Controller pass through two rubber grommets on the rear panel of the case.

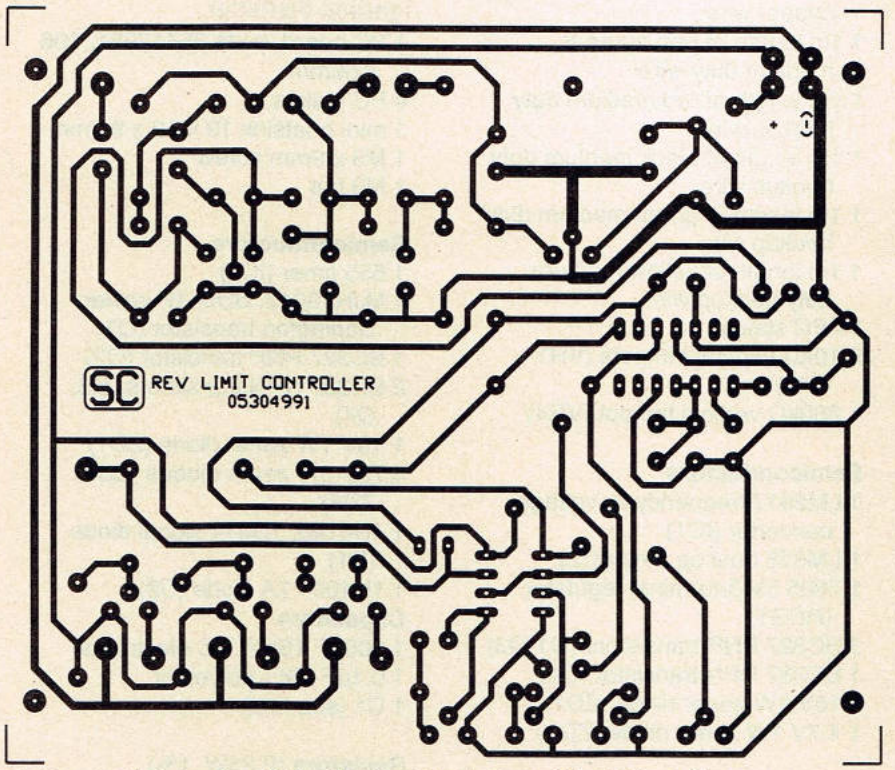


Fig.8: actual size artwork for the Rev Limit Controller PC board.

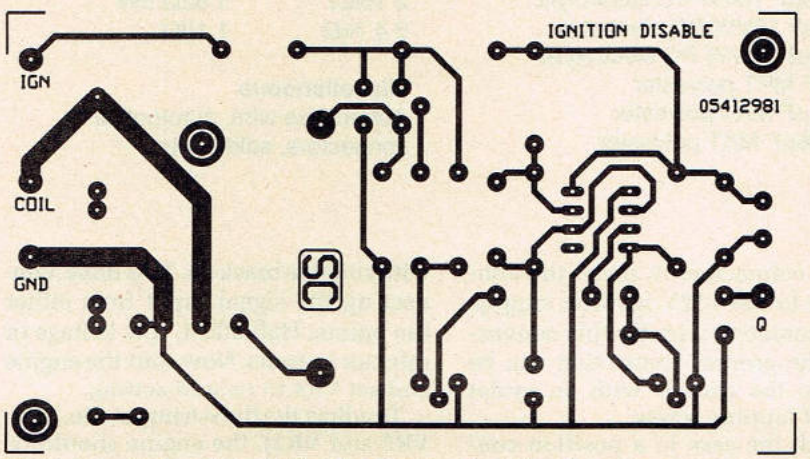


Fig.9: actual size artwork for the Ignition Switcher board.

WARNING!

This engine rev limiter blocks out ignition sparks and should only be used as a final protection against engine damage. It should not be used to limit engine RPM each time it is wound out at every gear change.

The reason for this is that at limiting there is the risk of backfire as the exhaust will contain an explosive mixture of unburnt fuel. In addition, the unburnt fuel adds to air pollution.

you need to drive the car along a quiet (no traffic) street in low gear while a passenger does the adjustments.

Adjust VR1 so that Lamp 1 lights about 1000 RPM below the red line. This done, adjust VR2 so that Lamp 2 lights about 600 RPM below the red line. Finally, adjust VR3 so that Lamp 3 lights at the red line.

If you have to wind trimpots VR1-VR3 fully clockwise in order to turn on their respective lamps, wind VR4 slightly clockwise. Alternatively, if these adjustments are too sensitive, wind VR4 slightly anticlockwise.

Connecting the boards

You can now attach the Ignition Switcher board to the Rev Limit Controller circuit to test for correct limiting action. The boards can be wired up using automotive wire, following the diagrams of Fig.7 and Fig.5 or Fig.6.

We used light duty wires for all wiring except for the wires to the ignition coil and ground. Be sure to ground the Ignition Switcher to a suitable chassis point using an eyelet and self-tapping screw. This is to allow the heavy current flow through Q1, when it is disabling the ignition.

The Ignition Switcher board must be insulated from the chassis by enclosing it in a plastic case or sleeving it with heatshrink tubing.

Now test the operation of the limiting action on the engine. The engine should lose power when limiting is taking place but we must caution against driving in this condition for anything more than a few seconds, because of the risk of backfire. SC

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.

Inverter transformer is critical

I purchased the 600W DC-DC Converter For Car Hifi Systems as described in the October & November 1996 issues and I am experiencing some problems. At zero or minimal load the unit appears to work, supplying the desired voltage of 55-60V. When a load of 5A or more is applied the transformer begins to hum, the frequency seems to drop, and the output voltage will drop to 20-30V. At this voltage there appears to be some RF noise.

The only difference between my circuit and your design is that the transformer outputs run over the coil and I was given aluminium link bars, not brass. The transformer core might be different as well. I am not too sure of the frequency response of the cores but I doubt that this is a problem. I also used male spade lugs to solder to the primary of the transformer.

Upon initial construction there was a problem with the pulse transformer. The circuit caused the power supply to hum as well as the pulse transformer while putting virtually nothing out; unable to light the two rail LEDs. The problem may have been with the insulation. I rewound the transformer and applied more applicable insulation. Thus I am presented with the current problem. I also changed the 1MΩ resistor to prevent transformer hum but it makes no difference. (S. T., via email).

● We are not sure what you mean by the statement "the only difference between my circuit and your design is that the transformer outputs run over the coil". If this implies that the transformer is not wound as described, then this will probably be your problem. Correct phasing and transformer winding layout are critical in such a compact high-frequency and high-power transformer. Any deviation from our design will cause losses and will prevent the transformer from delivering full power.

Note also that the transformer primary draws considerable peak current and the extra resistance caused by using spade lugs will introduce power losses due to contact resistance. Wiring to the transformer primary must be in accordance with our winding diagram. The use of aluminium bus bars instead of brass will not alter the converter's performance.

Woofer stopper makes crashing noise

I constructed the Woofer Stopper Mk.II (February 1996) from a kit, more or less when it appeared in your magazine. It has always had the following fault. It emits an initial loud cracking noise when the red button is depressed for "woofer-stoppering". It doesn't happen when the booster circuit is disconnected at, say, VR2. I tried the 47µF capacitor patch in your addendum to no avail.

I tried another pushbutton but it didn't make any difference. Actually it's a loud initial CRACK noise rather than a crackling. (T. S., Adelaide, SA).

● The loud cracking sound when the manual start button is pressed could be prevented by using a double pole pushbutton switch. Use one pole connected across the microphone in position S2 and the second pole between the base and emitter of transistor Q3.

The second pole will discharge the 47µF capacitor across the base and emitter of Q3 at the instant the Woofer Stopper is started with the switch. This will prevent IC6 from the high gain burst at the start of the tone.

Double pole momentary contact pushbutton switches are available from Dick Smith Electronics, Jaycar and at Altronics. They normally have changeover contacts so be sure to connect to the common and normally open contacts.

Telephone line suppressor wanted

I've looked through your index but I can't find any mention of circuits for a telephone line spike suppressor to protect a computer modem. Any pointers on how to build such a monster. (S. S., Cairns, Qld).

● We have not published a telephone line protector but you need more than that anyway if you are going to effectively protect a modem, fax or whatever. What you really need is a filter/surge protector which acts on the mains supply as well as the phone lines. Such products are prescribed items and must be type approved. You can buy them from companies such as Avico Electronics. Their phone number is (02) 9624 7977.

Substitutions in 15W class-A amplifier

I have yet to start construction of this project and have just received the kit from Altronics. I have a few questions. Can I substitute a Jaycar log dual-gang 16mm (Cat. RP-7756) 10kΩ, the Jaycar log dual-gang 24mm (Cat. RP-3758) 25kΩ or the Dick Smith 16mm dual-gang 41-click 50kΩ or 100kΩ potentiometers? I think the click type would give it a more quality feel.

Can I include a balance control such as the Jaycar dual-gang 10kΩ M/N potentiometer? On the question of heatsinks, your specification is for 300 x 75 x 49mm. Can I substitute the Jaycar HH-8546, measuring 200 x 75 x 48mm?

There is no on/off switch on the power amplifier. If the power supply is to be remote, should the amplifier not have a switch? Jaycar has a good selection of 19-inch rack mountable boxes. Can I just bolt the heatsink to

Controlling two garage doors

I have a query about the UHF Remote Switch in the December 1989 issue of SILICON CHIP. Currently we have a commercially built automatic garage door opener and its Tx/Rx frequency for the remote control is fixed at 315MHz. We have two garage doors and I am currently building an automatic garage door opener for the other one.

Ideally, both garage doors should run on the same frequency, eliminating the need for two transmitters. I would like to know what modifications are needed to the UHF receiver kit for a frequency of 315MHz. (Bernard – via email).

• You have two problems to resolve. First, you must make the kit transmitter run at 315MHz to match your garage door controller and second, you must match the encoding of the kit transmitter to that of the receiver. If you are going to use the same transmitters for both doors, then we assume that both will have the same encoding and that both doors will open and close simultaneously. However, trying to match the encoding will probably only be possible if the encoder chip in the kit transmitter is identical with that in the commercial transmitter.

If you want the doors controllable separately, then you will need separate transmitters and receivers and different encoding/decoding for each transmitter/receiver pair.

If that is what you want, you would be wise to employ a more recent design of UHF remote. We would recommend the design featured in the February 1996 issue of SILICON CHIP as it can easily be shifted in frequency. However, if you are going to have completely separate controllers, there is probably no point in shifting the frequency.

the sides of these boxes? (D. F., Sydney, NSW).

• You can substitute the volume potentiometer but keep the resistance as low as possible. A value of 50kΩ or 100kΩ will definitely increase residual noise. Incorporating a balance control will also increase noise. We would recommend against using the smaller Jaycar heatsink as it will become substantially hotter.

You can bolt the heatsink up to the case but then you will need to make cutouts in the case so that the transistors can be bolted directly to the heatsink. We also recommend against using a separate power switch for the amplifier because it will mean additional wiring inside the chassis and the power supply wiring is quite critical to obtaining the very lowest distortion.

Repairing scratches on CDs

Have you have come across any solution for removing scratches from CDs? I have tried using very watered down toothpaste with limited success. Is there any better way or do I buy a new CD? (E. W., via email).

• In this case, prevention is definitely better than cure. There is no fix that we know of for scratches. Using any abrasive mixture can only make the scratches worse. It is most important not to get scratches on the CD's label as this protects the reflective aluminium layer. Once that is damaged, the CD is usually unplayable.

Boosting CB transceiver power

You have done many different projects over the years, a lot of them very informative and useful for everyday things. I was wondering if it was possible to do a project on boosting performance of low-powered citizen band transceivers. I was given a pair of Radio Shack TRC-92 transceivers last Christmas and they perform reasonably well when up in a high-rise building overlooking the water. Because of line of sight, the range would be about 400 metres; not too bad for an output of only 50mW.

I was wondering if this could be boosted using the same board and just using more powerful components, to an output of between 200-500mW.

Is it possible to get a circuit diagram of the TRC-92 and if you cannot help me out in this matter, who could possibly assist? (Z. G., Brisbane, Qld).

• It may well be possible to boost the performance of your CB set since manufacturers often use the same boards for different models in their range. However, you would certainly need the circuit and wiring diagram to start and then you would need a source of higher power components.

It is highly likely that you will need higher rated components for the tank circuit, as well as the transistors themselves. The problem is that even if these components are readily available, their cost may make the whole project not worthwhile.

IR remote control for TVs & VCRs

I would like to know if you have ever featured an IR remote control project, one that has at least six codes that can be programmed to operate popular TVs/VCRs.

I ask this because there are (as far as I am aware) no pre-built universal remotes on the market that have only a few buttons and that can be made to say, change the volume on the TV and change channel on the VCR. They only operate one machine or the other. Or, if they operate more than one machine, they have too many buttons.

I'd like to find out because I want to build one for my technophobic grandparents. If you have featured such a project, I will request a copy of the article. (Luke – via email)

• We agree that typical learning remotes have too many buttons but we don't have a circuit which will solve your problem. Why not program a learning remote with the buttons you want and then tape or block off all the other buttons? It will be the cheapest and easiest way to solve the problem.

We have also seen some very simple learning remotes with large buttons and they would seem to be the ideal answer.

Leaking fuel monitor for boats

I am interested in the Exhaust Gas Monitor which was published in the July 1899 issue of SILICON CHIP. Could you advise me if this project can be easily modified to monitor fuel fumes

Problems with ignition misfire

I recently purchased and constructed the Universal High Energy Ignition, as featured in the June 1998 issue of SILICON CHIP, and I have been having some trouble with the engine misfiring at medium RPM. When I take second gear to 50km/h (about 3500 RPM; I can't be sure as my tacho stopped working), the engine suddenly starts misfiring to the point where it is barely firing at all and slows right down.

It misfired much earlier when I had the ballast resistor connected, so I've put it down to the current limit adjustment (adjusting the 100Ω trimpot) but my problem is that I can only get it to read about 190-200mV instead of 250mV as it should be. I was wondering if you know any way to get it up to 250mV or how to resolve the problem.

To help you out, I have a single new Bosch GT-40 RT coil and twin points distributor (both points are connected to the electronic ignition as it wouldn't work with just one connected – I have a strange twin-points system). The car is driveable but since it is also occasionaly used for racing, it needs to rev out to at least 5000 RPM without missing, hence the point of getting the ignition in the first place.

I have never had any troubles with any of your designs in the past and I'd like to compliment you people for doing a great job. (Michael – via email).

● Normally, if you are only able to obtain around 190mV across the 0.1Ω sensing resistors, we would be inclined to think that the coil primary resistance was too high to enable the design current of 5A to flow. However, the fact that you are using a GT40 sports coil puts an entirely different complexion on the problem.

These sports coils draw far more current than the standard coils and in a standard Kettering system, the points will usually have a greatly reduced life. But when used with our High Energy Ignition system which has dwell extension, the coil draws even higher current and may seriously overheat. We issued a warning about these coils in the Notes & Errata in the December 1998 issue. In brief: don't use them, especially not with any transistor-assisted ignition system and even more especially not with any system which has dwell extension.

Therefore, the first step is to toss the GT40 coil and get the system going with the original equipment coil. By the way, we suspect that the GT40 coil may be breaking down at 3500 RPM, which is the cause of the miss.

Now why can't you get the full 250mV across the 0.1Ω sensing resistors? We suspect that these might have increased in value, if they have been overloaded. Also check that all supply and return connections to the case are low resistance.

The current limit feature can be disabled by replacing the 100Ω resistor between pin 8 of IC1 and ground with a wire link and removing the 33Ω resistor at pin 8 plus trimpot VR1. Make sure that the coil ballast resistor is in place if you disable the current limit.

in an enclosed space such as the engine hutch of a boat? (Drew - via email).

● The exhaust gas monitor only tests for carbon monoxide. It needs a hydrocarbon sensor to make it suitable for monitoring fuel fumes. While these sensors were readily available in Australia years ago, they are not readily available now, as far as we know. We do plan to present a new exhaust gas (CO) monitor within the next few months.

Exploding FETs in power supply

I saw the item in "Ask Silicon Chip" pages January 1999, where A. Grange mentions some problems he had with the 40V 8A Power Supply kit. I have had exactly the same problems with my power supply as well, the unit squealing when only drawing a moderate current and with the current limit output setting cranked up. Also, I had both my FETs explode when I was drawing 8A from the power supply, when I was calibrating it.

In your reply to A. Grange, I cannot see any suggestions as to what may be causing this. I tried replacing the blown transistors and had them physically separated from the heatsink to make sure that it wasn't just a wonky mica washer that was causing a short. Then without a load connected, I turned the power supply on only to have the FETs explode again. I think that it could be a shorted turn in the output transformer causing the transistors to explode but I haven't had a chance to verify this yet.

When I get my new FETs and check out everything in the circuit do you think it would be a good idea to draw a maximum of 4A from the power supply to stop the FETs exploding again? (Mark – via email).

● The BUK436-200A Mosfets should not be destroyed under normal operating conditions. Consequently, we suspect a faulty component or PC board problem. Check the PC board for shorts or breaks in the tracks and for correct component placement. Check the polarity and operation of the 150V zener diodes and the 1N914 diodes between the gate and drain of Mosfets Q1 and Q2.

You could use the 1N4936 diode (available from Dick Smith Electronics) in place of the 1N914 to increase the voltage and current rating for diodes D5 & D6, if these appear to be faulty.

The squealing noise can be reduced by adding a small value of capacitance between pin 1 of IC1 and ground. Try 270pF as a starting point.

The dead time for IC1 can be increased slightly to prevent conflicts between Q1 & Q2 at very high power delivery. We recommend using a 1MΩ resistor between pins 4 & 14 of IC1. Also check the polarity and operation of the 1µF capacitor at pin 4.

Higher rated Mosfets could be used in place of the recommended types which may reduce the incidence of failure. The IRFP260 Mosfet could be used. It has a current rating of 46A compared to the BUK436-200A at 19A.

Alternatively, use the IRFP264 which has a 38A and 250V rating.

FM stereo transmitter works in mono

After purchasing the kit described in June 1988 issue, I have now finished construction. Although it seems to work fine, I have a few queries. The unit is used to transmit audio from a home PC, from a stereo 16-bit sound card, to a hifi stereo receiver and amplifier. Normal output from this source has been verified as stereo. My problem is that the receiver "stereo tuned" light is lit but the signal heard in the speakers is mono; ie, both channels are received as mixed into two identical signals.

This was confirmed by using the software to "pan" a fixed tone from one channel to the other. Although it is heard to pan from side-to-side in the PC headphones, when directed through the transmitter there is no panning on the receiver although the signal is present in both speakers.

I have talked to the kit supplier and he advised me to change the crystal oscillator as he thought it may be the wrong type. This was done with no change in the result. Am I expecting too much or is this only a 2-channel transmitter, or is it true stereo? (Andrew – via email).

● The FM stereo transmitter does indeed transmit in genuine stereo and produces the 19kHz pilot tone along with a multiplexed stereo signal. An FM stereo receiver will decode the signal into genuine stereo. The fact that your receiver is indicating "stereo" does mean that the transmitter is sending the requisite 19kHz pilot. This indicates that the 38kHz crystal is operating but does not necessarily mean that the transmitted signal is stereo.

The transmitter should be tested by applying signal into one channel only and checking that the receiver only has sound output in that channel. If the signal is in both channels you can first check the receiver to be sure that it does produce a stereo signal from off-air stations. Secondly, perhaps there is a short on the PC board that connects the left and right channels together. This could be somewhere in the component chain from the left input to pin 18 of IC1 or from the right input to pin 1 of IC1. Perhaps there is a short between pins 16 and 17 of IC1 which is causing the left and right channels to mix. You may also wish to check the value of VR3.

These are available from Farnell. Phone (02) 9645 8888.

Spacewriter doesn't work

I assembled the Spacewriter project as described in the May 1997 issue but unfortunately the record section isn't working. Whenever I insert a D-25 socket in the printer port, five of the seven LEDs (except the top one and the second from the bottom) glow continuously on both the Read and Record switch positions. I tried to record the message but was not able to record it. I suspected the RAM but changing it made no difference.

All the ICs are getting 5V on their particular pins and the Spacewriter section seems to be working OK. When I wave the circuit, the LEDs flash randomly and the clock rate is also working properly through VR1. I will be grateful if you could point out my possible mistake. (Farid – via email).

● We suspect that your problem with the Spacewriter is the printer port addressing. The spcwri.exe file requires that the printer port address be 0378 (hexadecimal). You can check that your computer uses this address by looking into the MSD program or Device Manager. This is detailed on page 61 of the May 1997 issue. If you cannot use this address, you can operate the Spacewriter program using Basic and the spcwri.bas Spacewriter software. You will need to change the address from 0378 to the address used by your computer's printer port in the spcwri.bas file.

If this doesn't help, check that the DB-25 socket is wired correctly. The numbers of each pin are embossed on the socket. Also check that pin 20 is connected to the computer's ground.

Remote control for factory gates

I recently constructed a UHF remote control for use on our factory hydraulic gates. The whole unit works fine until the receiver module is installed in the control enclosure which is 16mm thick steel. The aerial is left outside via a small hole drilled in the enclosure but the range has dropped back to less than 5m whereas before it was greater than 40m. Can I use and aerial on the outside of the enclosure or increase the power of the transmitter to improve my range? (Simon – via email).

● Yes, use the aerial outside the enclosure and you can try using a longer aerial as well. If that is not sufficient, try using a short wire aerial on the remote transmitter itself. We described how to do so on page 89 of the December 1998 issue.

Audio recording with a VCR

I like recording various radio programs. Some of these programs go for one hour or longer, so I attempted to record the program (via the headphone out to the audio-in connection) on my VCR. Unfortunately, the VCR is a fairly modern one and blanks the screen if there is no valid video sync pulse being recorded, which cuts off the audio that I've recorded. I know the audio signal has been recorded as I played the tape back on someone else's older VCR.

Have you built a cheap kit which could be plugged into the video input on a VCR, to fool the VCR into playing back my audio signal, without blanking the screen? (Owen – via email).

• It is highly likely that you need a proper composite video signal rather than just a sync signal, to prevent the TV screen from being blanked. With that in mind, the easiest approach may be to build a version of our TV pattern generator, without the pattern switching. Just set the circuit to produce, say, a crosshatch pattern. The pattern generator was published in the June & July 1997 issues.

Electrolysis concern in coolant alarm

I installed the Coolant Alarm from the October 1994 issue in a Skoda

IR remote control for old TV

I have recently put together an infrared remote and attached it to my old TV (with pushbutton channel selection) as an on/off switch and channel changer. It is operating fine as it is but I am looking for a method of perhaps storing the last sent signal in some kind of a buffer to be retransmitted when the next button is pressed, thus turning of the previously selected channel. As it is, you have to turn off the channel you are on before selecting the new channel.

I have used two Dick Smith Electronics 4-channel infrared remote control kits (Cat. K-2810). I have used Channel 8 to operate the on/off relay, with the other seven outputs for the seven channel positions. Each of these outputs drives two 5V relays to switch the signals. These I have connected directly to the back of the original switch.

These kits use the MC145026 9-bit trinary encoder IC for the transmitter and the MC145027 9-bit trinary decoder IC for the receiver. The signal is inverted and two 74HC74 dual D flipflops are used as latches or not, depending on the intended application. Could the VT outputs be utilised in some way for this purpose?

Could you please suggest possible components and/or a circuit which may suit this application? (W. W., Murwillumbah, NSW).

● We don't understand why you have to turn off the presently selected channel when a new channel is selected. In any conventional remote system, such as a hifi amplifier, it is not necessary to turn off individual program sources (eg, CD player) when another program source is selected. Of course, in an integrated system, sources are usually turned off when a new one is selected but it does not have to be done that way.

Nor can we see any way of storing the last transmitted signal. Possibly a better way would be to have a logic selector system, perhaps using a counter (4017?) or shift register so that when a new count (data) was selected, the old one could naturally be de-selected.

about two years ago and find that it works just fine. Now I'm about to install another one in a 1992 Renault 19. My concern is that a radiator expert on a motoring radio program raised the possibility (and he quoted actual occurrences) of electrolysis occurring with cars fitted with aluminium radiator cores. Apparently, a current of 50mA is enough to ruin a radiator in a short time.

My knowledge of electronics is limited to soldering kits together. Therefore, I would appreciate it if you could clarify as to whether there is a possibility of electrolysis occurring with the coolant level alarm. I understand that all the late model cars are fitted with aluminium radiator cores. It would be great if you could show how to check if electrolysis is happening, with a multimeter. Do aluminium radiator equipped cars have a sacrificial anode in the system? (J. B., Surrey Hills, Vic).

● While there is a potential problem with electrolysis occurring in aluminium radiators, the sensor current used in our circuit is very small, at around 47 microamps. This is determined by the 100kΩ sense resistor and 4.7V supply.

You can confirm this current by connecting your multimeter in series with the sensor lead.

As far as we know, there is no sacrificial anode in car radiators. Inevitably though, the car's aluminium head will perform the same function.

Inverter for a scanner

I have a 12VDC car battery and I wish to get 10VAC @ 50Hz from it to power a VHF and UHF scanner drawing about 350mA. Have you published a circuit for such an inverter? (A. P., Gladstone, Qld).

● The project most suitable to your application would be our 12V-to-240VAC 40W inverter described in the February 1992 issue. You would have to use it with a 10VAC plugpack to drive your scanner.

However, we wonder if the scanner does not already have a 12V DC input or failing that, does not actually run from 12V DC after the 10VAC is rectified. You may even be able to feed 12V DC into the 10VAC input, if it is followed by a bridge rectifier. It would be worthwhile investigating this point.

Notes & Errata

LED FUN, March 1999: we have been advised by Dick Smith Electronics that a batch of PIC12C508 microcontrollers have been found to latch into Mode 1 when Mode 3 is selected. The solution is to change all 2.2kΩ resistors in the circuit to 270Ω. All resistors in the supplied kits will now be 270Ω. **SC**

WARNING!

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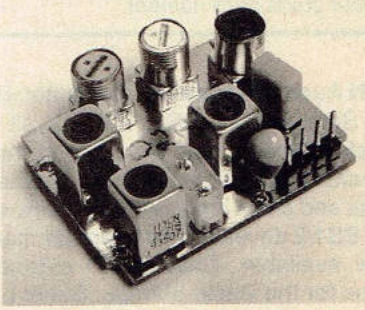

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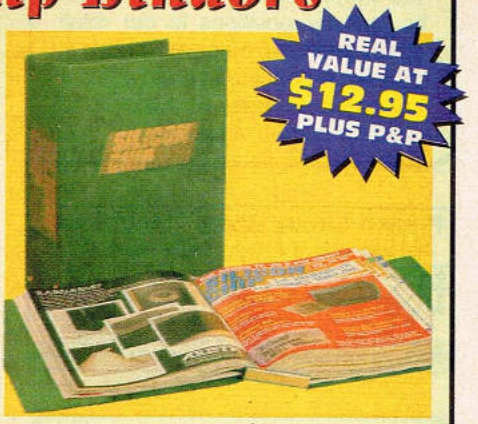

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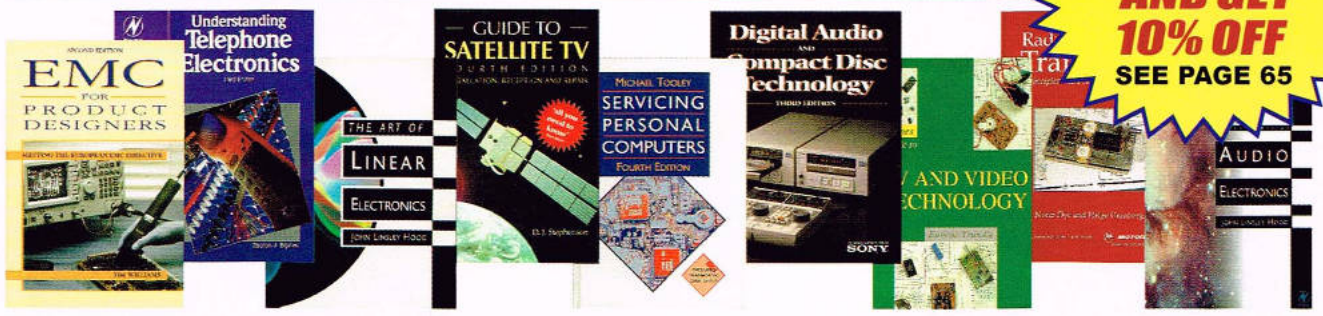

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